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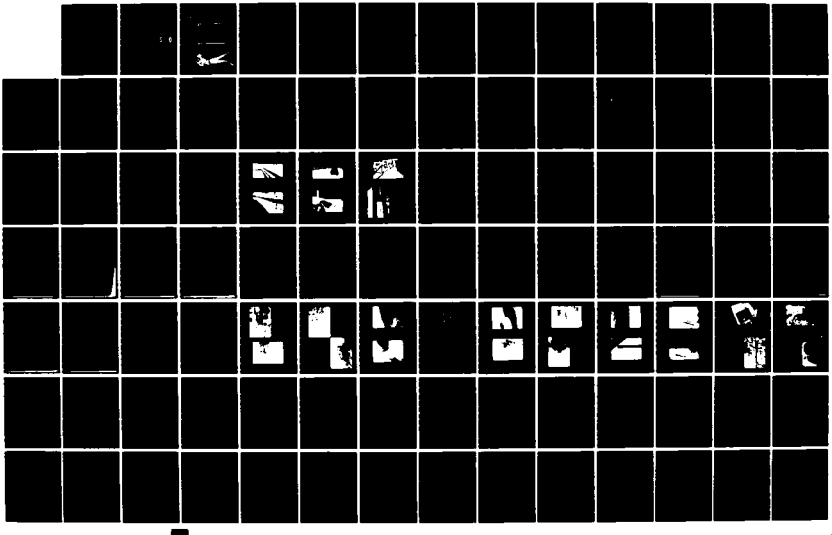

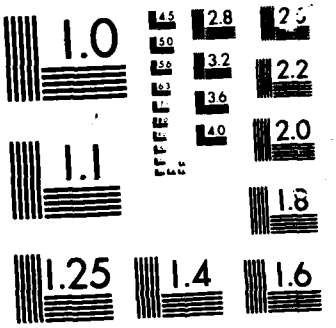

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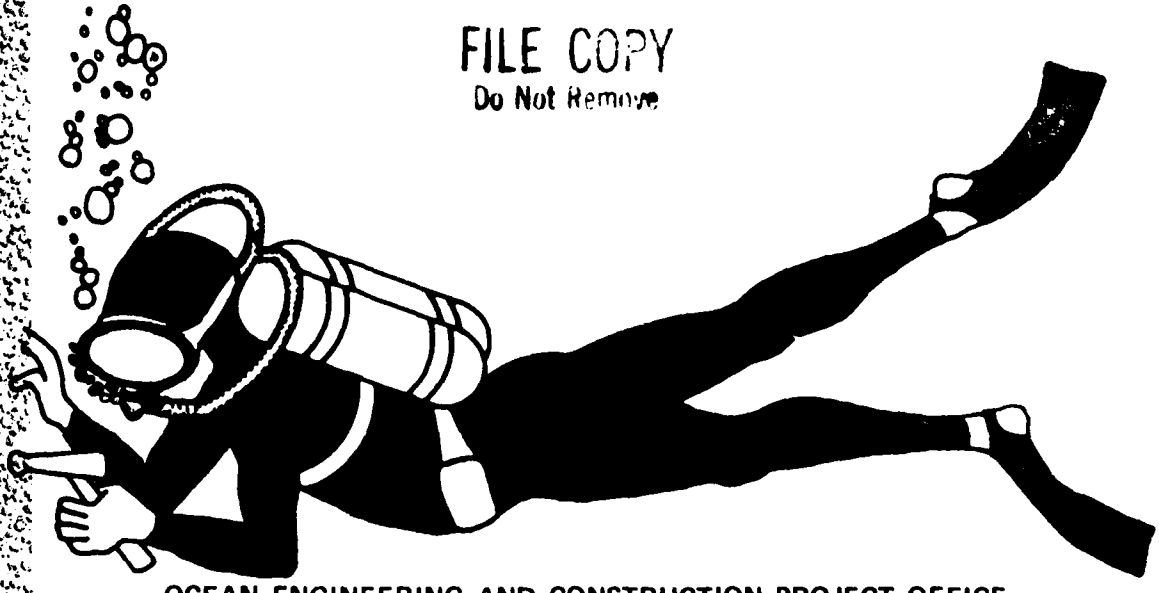

OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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The objective of the underwater facility assessment conducted at the Naval Submarine Base, Bangor, Washington, is to assess the physical condition and repairability of the structural members supporting the Magnetic Silencing Facility, also known as the Deperming Pier, at the Naval Submarine (Con't)

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Base, Bangor, Washington. The Level II inspection procedure carried out was designed to insure the acquisition of sufficiently detailed data related to the internal structural integrity of each pile inspected as to enable determinations ot be made of the overall bearing capacity and lateral stability of the pier. The data provided is sufficiently detailed to facilitate comparisons with subsequent periodic inspections for purposes of determining progressive dterioration with time. In addition, the ultrasonic non-destructive evaluation procedures employed for this project, will be documented by the contractor with the objective of possibly developing them, through experience on subsequent inspections, into standard inspection procedures for all future NAVFAC evaluations of underwater timber piling.

The current inspections covered 407 piling (60% of the total of 650 piling in the facility) throughout the structure including the Access Trestle, Header Pier and East and West Piers. Critical elements were photographed.

All examined piling, with the exception of three piles in the West Pier, were found to be in excellent condition. Piles 77W-3N and 77-3S of the West Pier have been severed and smashed as a result of vessel impact. In addition, the remaining stubs have sustained extensive teredine marine borer infestations and damage. It is recommended that fendering protection be provided for that north end of the East and West Piers. Pile 51W-2E, is broken at the mudline and has sustained Bankia damage at the break. The damaged piles will require strength restorative repairs or replacement.

With the exception of the above noted damage, the examined piling were found to be in excellent condition. No damage or failure was noted in any other area of the facility.

UNDERWATER FACILITIES
INSPECTION AND ASSESSMENT

AT

MAGNETIC SILENCING FACILITY
NAVAL SUBMARINE BASE
TRIDENT SUPPORT SITE
BANGOR, WASHINGTON

FPO-1-80(13) **October, 1980**

Performed for:

Ocean Engineering and Construction Project Office
Chesapeake Division
Naval Facilities Engineering Command
Washington, D.C. 20374

Under:

Contract N62477-80-C-0265
Task 1

By:

J. Agi & Associates Inc.
1414 Alaskan Way, Suite 600
Seattle, Washington 90101

Project No.: 80-1-2-027

FOREWORD

The scope of the inspection at the Magnetic Silencing Facility, at Bangor, WA and the detail to which it was performed and reported was tailored specifically to the conditions at this facility. This report and the procedure associated with its formation are not intended to be standards for inspections or reports covering other activities. Attempts are being made, however, toward establishing standards for procedures and formats for inspection and assessment reports. Through these standards, inspections performed by different persons, on many facilities and under a wide range of conditions can be effectively compared. It is expected that the inspection and assessment of the Magnetic Silencing Facility, like previous operations mandated under the underwater portion of the Specialized Inspection Program, will contribute significantly toward achieving that objective.

It should be noted that the choice of the level of inspection and the procedural detail to be employed will be an engineering judgement made separately for each activity/facility to suit its unique situation and needs. Accordingly, the procedures used at the Magnetic Silencing Facility, rather than serve as a detailed model for inspections elsewhere, will provide guidance with general applicability to some types of future inspections.

EXECUTIVE SUMMARY

The objective of the underwater facility assessment conducted at the Naval Submarine Base, Bangor, Washington, is to assess the physical condition and repairability of the structural members supporting the Magnetic Silencing Facility, also known as the Deperming Pier, at the Naval Submarine Base, Bangor, Washington. The Level II inspection procedure carried out was designed to insure the acquisition of sufficiently detailed data related to the internal structural integrity of each pile inspected as to enable determinations to be made of the overall bearing capacity and lateral stability of the pier. The data provided is sufficiently detailed to facilitate comparisons with subsequent periodic inspections for purposes of determining progressive deterioration with time. In addition, the ultrasonic non-destructive evaluation procedures employed for this project, will be documented by the contractor with the objective of possibly developing them, through experience on subsequent inspections, into standard inspection procedures for all future NAVFAC evaluations of underwater timber piling.

The current inspection covered 407 piling (60% of the total of 650 piling in the facility) throughout the structure including the Access Trestle, Header Pier and East and West Piers. Critical elements were photographed.

All examined piling, with the exception of three piles in the West Pier, were found to be in excellent condition. Piles 77W-3N and 77W-3S of the West Pier have been severed and smashed as a result of vessel impact. In addition, the remaining stubs have sustained extensive teredine marine borer infestations and damage. It is recommended that fendering protection be provided for the north end of the East and West Piers. Pile 51W-2E, is broken at the mudline and has sustained Bankia damage at the break. The damaged piles will require strength restorative repairs or replacement.

With the exception of the above noted damage, the examined piling were found to be in excellent condition. No damage or failure was noted in any other area of the facility.

EXECUTIVE SUMMARY TABLE

Piling included in the current inspection:

		CONDITION
1. Access Trestle:	Bents 1, 2, 3, 4, 7, 8, 11, 12, 15, 16, 19, 20, 23, 24, 27, 28	All examined piling in good condition.
2. Header Pier:	Bents 30, 33, 34, 35	All examined piling in good condition.
3. West Pier:	Bents 37W, 38W, 40W, 42W, 43W, 47W, 50W, 51W, 54W, 55W, 58W, 59W, 62W, 63W, 66W, 67W, 70W, 71W, 72W, 73W, 74W, 75W, 76W, 77W	Pile 51-2E broken at mudline and infested by marine borers. This pile will require repair or replacement. Piles 77W-3N and 77W-3S broken at -27'. These piles will require repair or replacement. (At this writing, repairs are being implemented.)
4. East Pier:	Bents 42E, 43E, 46E, 47E, 50E, 51E, 54E, 55E, 58E, 59E, 62E, 63E, 66E, 67E, 70E, 71E, 72E, 73E, 74E, 75E, 76E, 77E	All examined piling in good condition.

NOTE: The above destroyed piling have sustained severe mechanical damage which has facilitated marine borer infestation. All piling should be adequately protected from mechanical damage in order to insure integrity of the treated protective layer of the pile. Once the creosote protection is breached, destruction of the pile by marine borers will occur very quickly.

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SECTION 1 - INTRODUCTION

1.1 CONTRACT

Department of the Navy
Chesapeake Division, Naval Facilities Engineering Command
Building 212
Washington Navy Yard, Washington, D.C. 20374

1.2 CONTRACT NO.

N62477-80-C-0265

1.3 CONTRACT DATE

August 25, 1980

1.4 CONTRACT DESCRIPTION

The contractor shall provide all required technical, non-personnel engineering services for Ocean Engineering Services in support of underwater facility assessment at various locations. The initial award under this contract is for engineering services for a Level II inspection of 407 timber piling at the Magnetic Silencing Facility at the Naval Submarine Base, Bangor, Washington.

1.5 INTRODUCTION TO PROJECT

This report is prepared under the Underwater Inspection Program conducted by the Ocean Engineering and Construction Project Office (FPO-1), Chesapeake Division, Naval Facilities Engineering Command as a part of NAVFAC's specialized Inspection Program. This is a task oriented engineering service program in support of inspection, analysis and design of repairs of the submerged portions of Navy Waterfront Facilities.

This report covers the inspection carried out at the Magnetic Silencing Facility at the Naval Submarine Base, Bangor, Washington. The purpose of this project is to provide a Base Line Assessment in sufficient detail to facilitate comparisons with subsequent periodic inspections for purposes of determining progressive deterioration of the facility with time. In addition, the ultrasonic non-destructive evaluation procedures used shall be documented as a candidate for possible development into standard inspection procedures for future NAVFAC evaluations of underwater timber piling.

A description of the activity, its location and mission is provided. Detailed data is given relative to the Magnetic Silencing Facility in terms of location, function and construction.

1.6 DEFINITION: LEVEL II INSPECTION

Level II underwater inspections quanitify the structural condition of a facility through definitive engineering-data-measurement techniques. This type of inspection is required in cases where engineering evaluations, structural analyses, and design of repairs are required.

Level II inspections normally include visual documentation using underwater television and/or photography and detailed measurements including ultrasonics, X-ray diffraction, magnetic particle testing, dye penetrant testing or other diver non-destructive testing techniques. Corings of concrete, wood, and steel structures are also sometimes required. Detailed dimensions will also be taken.

Detailed results with respect to individual piling, overall assessment of structural condition, and recommednations are provided.

SECTION 2 - ACTIVITY DESCRIPTION

2.1 NAME OF ACTIVITY

Naval Submarine Base, Bangor, Washington - TRIDENT Support Site.

2.2 LOCATION OF ACTIVITY

The TRIDENT Support Site is located on Kitsap Peninsula in Puget Sound, due west of Seattle, Washington. The site area is that generally included within the activity area of existing Bangor Annex, Naval Torpedo Station, Keyport. The site is rural in nature and the nearest urban areas are Silverdale, Poulsbo and Keyport, with approximate populations of 1,000, 1,700 and 500 respectively. The Greater Seattle Metropolitan area with a population of approximately 500,000 is about one hour east by ferry and highway. Bremerton, site of the existing Naval Shipyard, is located 13 miles south of the Bangor Annex. The Naval Torpedo Station, Keyport, is located four miles east of the Bangor TRIDENT facility.

2.3 MISSION OF ACTIVITY

The purpose of the TRIDENT system is to provide a sea-based strategic deterent system with increased survivability, reliability and availability over existing Fleet Ballastic Missile Systems. Special maintenance and supply support facilities are needed to accommodate the mission on a full-time basis. The TRIDENT Support Site at Bangor Annex is designed to permit TRIDENT to meet this need. The functions included at the facility will include ship refit, missile support, site support and training personnel support.

2.4 DESCRIPTION OF ACTIVITY

This program is concerned with waterfront facilities which provide the interface between the submarines and the shore support activity. The waterfront facilities consist of five functional areas:

1. Refit
2. Explosives Handling
3. Magnetic Silencing Facility
4. Service Pier
5. Marginal Wharf

The task under the current contract covers only the Magnetic Silencing Facility (MSF).

The Deperming/Degaussing area provides the facilities to detect and remove the magnetic forces in the submarine. The facility consists of two principal components, the Deperming Berth and the Degaussing Range. The Deperming Berth is a non-magnetic wood pile pier adequate in size to berth a TRIDENT submarine and is equipped to remove magnetic forces which develop in the submarine. This project was carried out to inspect the wood marine piles, from mudline to cap, and to establish the "as built" base line conditions of the facility.

2.5 ENVIRONMENTAL DATA

The facility is located on the eastern shore of Hood Canal on the Kitsap Peninsula (see Figures 1-4). The region is a long, north-south lowland situated between mountain ranges on the east and west. The region's ecology is characterized by dense conifer forests.

The topography of Bangor Annex is predominantly flat to gently rolling. Hills and valleys onsite are irregular but have a general north-south trend. Three major streams and numerous minor drainages run through the site towards Hood Canal to the west.

The Hood Canal shore of the Bangor Annex is for the most part erosional, with steep wave cut slopes rising to more than 100 feet above sea level. The seashore environment is characterized by a slow erosion of the cliff and deposition of erosional debris (silts and sands) from the streams to offshore deltas.

The sea bottom slopes uniformly down toward the Hood Canal in a slope of about one in 10. Soils data indicates a major portion of the Bangor Annex is covered with glacial till of a dense gravel-sand-silt mixture. This relatively impermiable material varies in thickness from zero to more than 40 feet, with the thickest layer being in the southern portion of the site. Much of the till is covered by a relatively thin layer (10 feet) of medium dense sand and gravel with some areas of surface soils and gravel deposits.

Offshore, along the Bangor shoreline, the sea floor is covered with recent loose to medium dense granular materials at varying depths. At some locations, a wedge of till follows, thickening towards the center of the Canal. These sloping soils overlie and truncate a series of essentially horizontal sand silt strata. In the offshore areas, artesian conditions occur in areas where these silt strata exist. Offshore soil conditions were found to be generally good for offshore construction. Exceptions to this were found in areas where less suitable soil artesion conditions and till deposits occur and may require some remedial preparation for emplacement of waterfront facilities.

Climatic conditions of Bangor Annex are representative of the Kitsap Peninsula, with short, cool, dry summers and mild, wet winters. Annual precipitation varies from 30 to 70 inches with 75 to 80 percent of the annual rainfall occurring from October to March. The Kitsap Peninsula and Hood Canal are susceptible to slightly higher winds than other areas of the Puget Sound lowlands. The strongest winds are from the south and southwest and usually occur when intense Pacific storms move inland.

Precipitation Averages:

Keyport	-	30.66 inches annual rainfall
Bremerton	-	38.66 inches annual rainfall
Seattle	-	34.10 inches annual rainfall
Quilcene	-	50.90 inches annual rainfall

Tidal range at the site is:

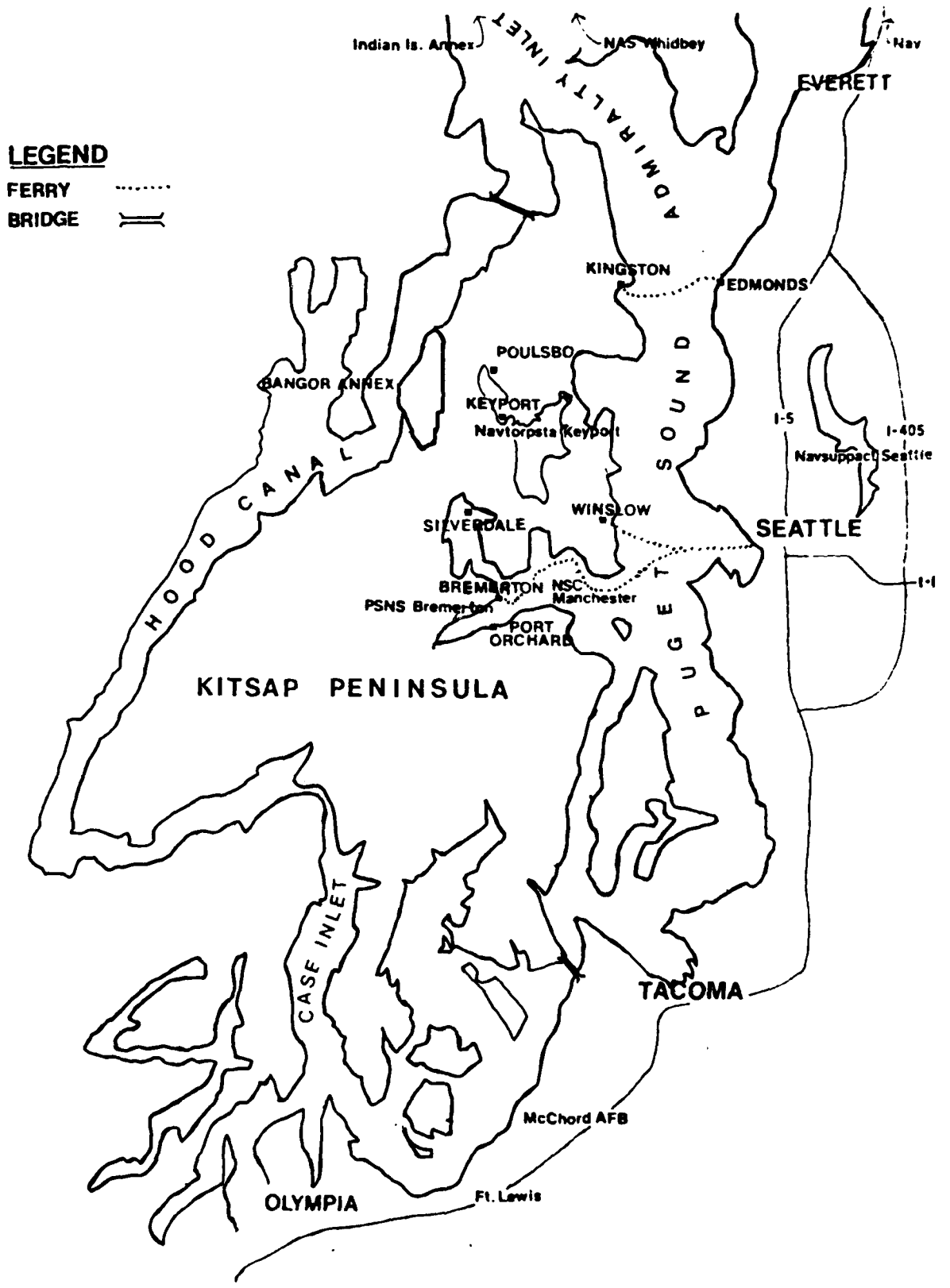
Extreme High Water (EHW)	-	+14.6 feet
Mean Higher High Water (MHHW)	-	+10.9 feet
Mean Tide Level (MTL)	-	+ 6.4 feet
Mean Lower Low Water (MLLW)	-	0.0 feet
Extreme Low Water (ELW)	-	- 4.5 feet

Elevations are based on Mean Lower Low Water which is 6.146 feet below Geodetic sea level datum of 1929 through the Pacific Northwest supplementary adjustment of 1947.

Wave forces at the site are based on an estimated significant wave height for a 75 MPH wind velocity over a maximum fetch of 12 miles.

Earthquake criteria established for Seismic Probability Zone 3 in accordance with NAVFAC P-355 and Collapse Resistance Criteria for critical structures in accordance with NAVFAC DM-2 Lateral Seismic Load Factors:

K = 1.0
C = 0.05/T 1/3 for each structural element
Z = 1.00



Trident Support Site

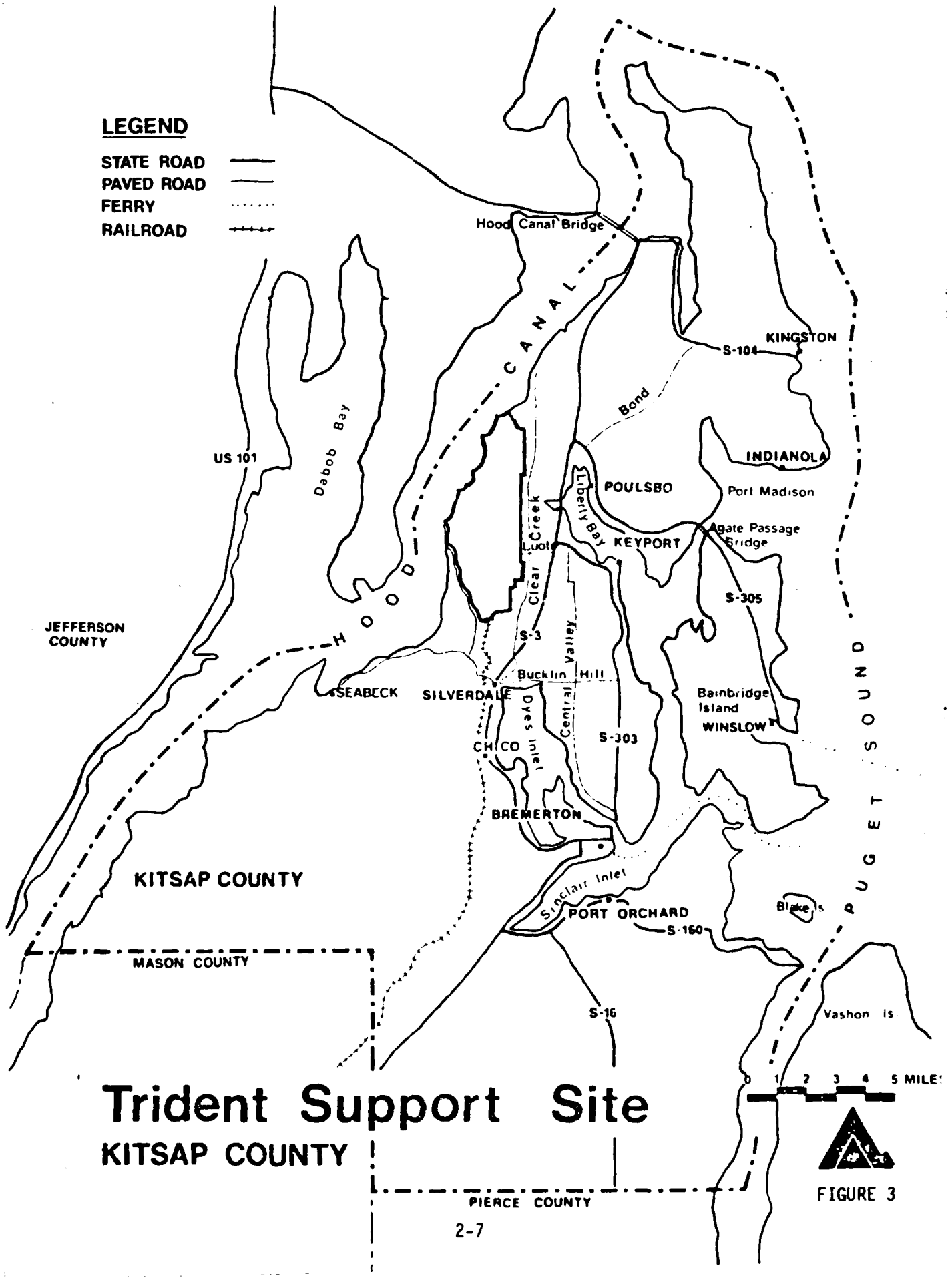
PUGET SOUND · AREA

FIGURE 1

Trident Support Site

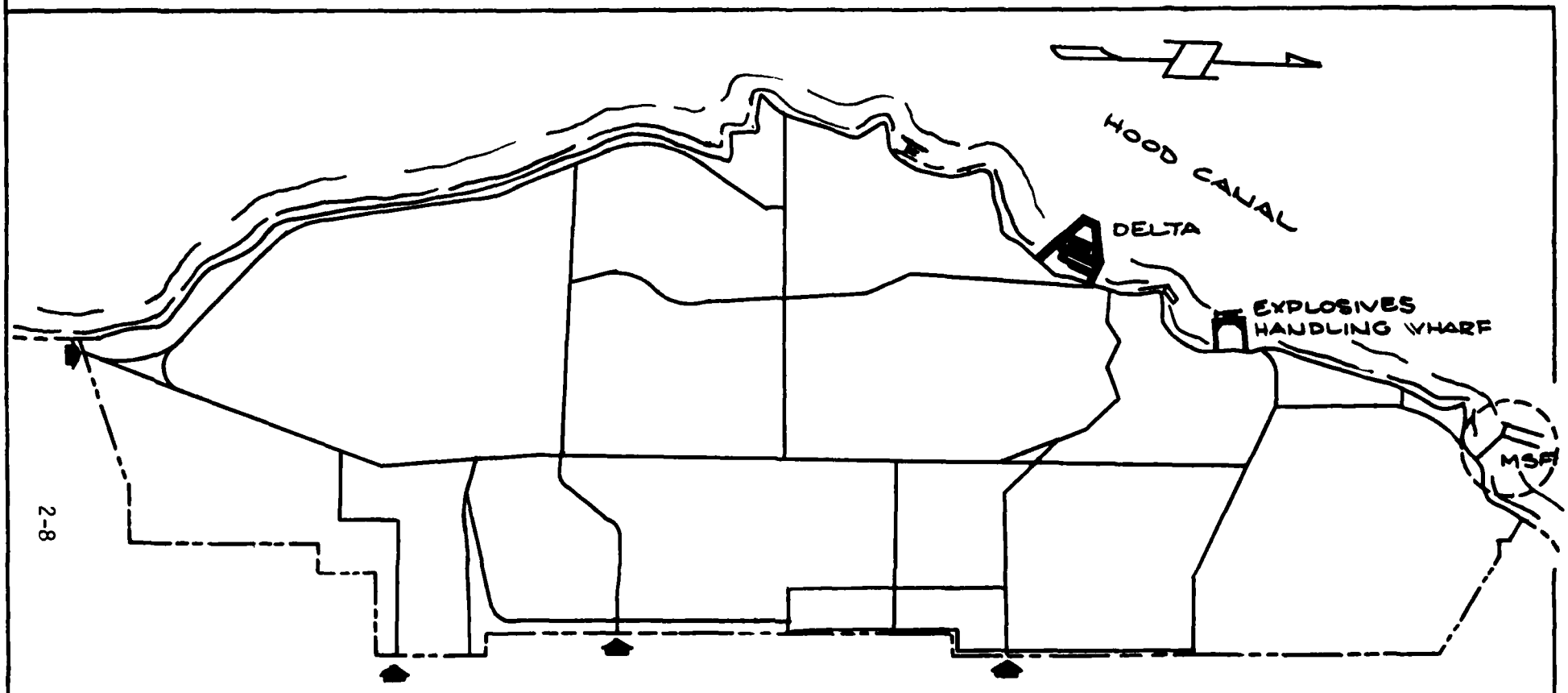
LOCATION-NW WASHINGTON STATE

FIGURE 2



Trident Support Site
KITSAP COUNTY

FIGURE 3



TRIDENT SUPPORT SITE GENERAL PLAN

LEGEND

- LAND ENTRANCE
- ROAD
- BOUNDARY

0 1000' 2000' 3000' 4000'

FIGURE 4

FIGURE 4

SECTION 3 - PROJECT DESCRIPTION

3.1 FACILITY INSPECTED

Deperming Pier, Magnetic Silencing Facility (MSF), Naval Submarine Base, Bangor, Washington.

3.2 FACILITY DESCRIPTION

The Magnetic Silencing Facility is located at the extreme north end of the Naval Submarine Base, Bangor. The structure extends out approximately 700 feet perpendicular to the shore. A 567 foot long by 15 foot wide Access Trestle joins a Header Pier and the 730 foot by 15 foot East and 745 by 15 foot West Piers. The entire structure is constructed on treated Douglas Fir piles in accordance with ASTM D25 specifications. (See Photographs 1 to 6 and accompanying drawings). The pile bents in the Access Trestle are composed of four and six piles each. The bents are numbered one through 29.5 from the shore, the pile rows are designated by consecutive numbers from the east. The Header Pier runs from Bent 30 to Bent 36.5 and the piles are designated consecutive numbers from the "inside" of the pier. The West Pier runs from Bent 37W to 77W and the East Pier extends from Bent 40E to Bent 77E. In both piers the piles are numbered from the outside towards the center line of the pier. (See the accompanying piling plans for overall layout and pile numbering.)

Extensive timber bracing extends down 12 feet from the pile tops. The Commercial Grade, No. 2, Douglas Fir-Larch bracing extends both with the rows and the bents. (See Photograph 5.)

The mudline to cap pile lengths range from 35 feet in the approach to 75 feet in the piers. Mean pile diameter in the Access Trestle ranged from 11" to 15". The pile butt diameters ranged from 16" to 19" with the average being about 17". Pile lengths and diameters for the individual piles are given in Table 1.

Maximum water depth encountered was approximately 65 feet (at MHW) at the north end of the East and West Piers. Underwater visibility ranged from two to five feet with some suspension turbidity encountered throughout the facility.

The two main, East and West, piers support the deperming mechanism. Above water this consists of cables extending between the piers supported by 50 foot poles on each pier. Underwater the cables extend between the piers at about two to five feet above the mudline. The underwater cables are supported by horizontal poles attached to piling in the pier bents.

Construction of the facility was completed in 1978. Hence at the time of inspection the structure was approximately two years old.

3.3 INSPECTION LEVEL

A Level II inspection was carried out. This included visual inspection and ultrasonic testing of the examined piles including photographic documentation.

3.4 INSPECTION PROCEDURE

3.4.1 Equipment

- B.C. Research ULTRASCAN-PTM4*, pile testing instruments.
- Underwater telephone.
- Nikonos II Camera with Metz GN41 Strobe in Underwater Housing.
- Calipers.
- Miscellaneous ancillary equipment and SCUBA equipment.
- See photographs 21 and 22 for ULTRASCAN-PTM4 instruments.

3.4.2 Background on Instrumentation and Methods

The ULTRASCAN-PTM4 pile testing instruments are the result of studies initiated, at B.C. Research in 1955, to develop instruments for nondestructive testing of in-place marine piling. It was found

* Patented

that the velocity and strength of sound waves passing through wood varied inversely with voids in wood caused by marine borers. Based on this principle, instruments were developed which use magnetostrictive transducers to provide an ultrasonic "scan" of the pile. The plane waves which penetrate the wood, from the transmitting transducer, initiate transmission of secondary sonic patterns in the direction of the wood grain. As these wave trains transmit along the axis of the pile they produce radial sets of waves which are picked up by the transducer. Undamaged wood is an excellent transmitter of these waves whereas damaged wood attenuates the sound. During the development stage extensive axial load testing of pile sections was carried out and correlations was established between the sonic readings and the remaining undamaged cross-section of the pile. A direct meter readout is provided showing the percentage of sound wood remaining. Verification and refinement of the initial methods has been carried out by testing in-place piling, removing the piles and subjecting them to inspection and axial load testing. Good correlation was found between the sonic readings, the remaining undamaged area of the pile and the strength ratings based on the sonic instruments.

The testing crew consists of two men, a SCUBA diver who provides visual observations and scans the entire surface of the pile with the sonic "probe" (see photograph 22), and a surface technician who monitors the observations and readings produced on the meter (see photograph 21). The probe is attached to the pile by the diver at the water surface. The diver then proceeds to scan the entire length of the pile from the surface to the mudline. The instruments provide a continuous cross-sectional area readout which is recorded by the surface technician. When the mudline is reached, the probe is moved onto the adjacent pile in the bent and the process is repeated from the mudline to the surface. Removal of fouling is not required for

operation of the unit. The pile "ratings" are given in terms of undamaged cross-sectional area remaining in each pile. These ratings are based on the least cross-sectional area found as revealed by sonic and visual data. The ratings are given in quartiles and indicate both the location and degree of loss of pile cross-section in damaged piles. Based on the data provided, the new L/d ratio of a pile can be established in light of damage found. This data, in turn, provides the basis for individual column analysis and overall structural analysis.

The ULTRASCAN is used to detect and assess marine borer and mechanical damage in the immersed areas of the pile from mudline to the high tide level. Additional inspection is carried out from the high tide level to the cap to locate any possible mechanical or fungal damage.

3.4.3 Reasons for Selection of Particular Instrumentation and Methods

Bankia damage in piling can only be determined by underwater inspection, with many attendant difficulties. If the Bankia are alive and the siphons are extended, recognition is not too difficult. If the siphons are retracted or the Bankia are dead, detection of the burrow openings is not easy. In many instances, fouling must be scrubbed off the piling in order to facilitate an inspection. If visibility is limited, as frequently occurs in industrial locations, visual inspection is hopeless. Even if teredine entry holes are observed, an evaluation of internal damage, by purely visual means, is not possible. (See photographs 23,24).

Because of these difficulties, the sonic testing method was initially developed to locate and evaluate teredine damage. It was felt that Limnoria damage could be readily detected visually, since the damage progressed from the surface inward. Experience, however, has shown that the sonic testing method substantially

enhances the detection and evaluation of damage even in areas where Limnoria is the primary source of infestation. Some of the reasons for this are as follows:

1. In areas with poor or nonexistent underwater visibility, sonic testing expedites the examination by locating the damage and providing a quantitative evaluation of the residual strength.

2. Limnoria attack very often takes the path of least resistance. That is, Limnoria will gain access into a pile through a small breach in the creosoted layer and destroy the untreated heartwood with very little surface evidence of damage. A good example of this is a U.S. Navy fuel dock. In this particular structure a considerable number of piles, which have been destroyed by Limnoria, show no obvious visual indication of damage. The reason for this is that the Limnoria has gained access to the pile through open boltholes. The boltholes are virtually impossible to detect unless all fouling is removed from the pile and a minute visual examination is carried out. This type of visual examination would be very time consuming and costly. It would be further restricted by poor underwater visibility.

3. Limnoria damage, particularly in southern waters, very often exposes the treated pile to teredine attack which would be very difficult to detect and assess visually.

3.5 SCOPE OF WORK

This project was carried out in order to acquire base line data for a new structure in its "as built" condition. The data provided will facilitate comparisons with subsequent periodic inspections to determine progressive deterioration with time. In addition the ultrasonic nondestructive evaluation procedures employed for this project shall be documented in

this report with the objective of developing them into standard procedures for future NAVFAC evaluations of underwater timber piling.

Piling in the following bents were subjected to evaluation for a total of 407 piling or 60% of the total number of piling in the facility.

Piles inspected in:

1. Access Trestle:

Bents	1	15
	2	16
	3	19
	4	20
	7	23
	8	24
	11	27
	12	28

2. Header Pier:

Bents	30
	33
	34
	35

3. West Pier:

Bents	37W	54W	70W
	38W	55W	71W
	40W	58W	72W
	42W	59W	73W
	43W	62W	74W
	47W	63W	75W
	50W	66W	76W
	51W	67W	77W

4. East Pier:

Bents	42E	58E	72E
	43E	59E	73E
	46E	62E	74E
	47E	63E	75E
	50E	66E	76E
	51E	67E	77E
	54E	70E	
	55E	71E	

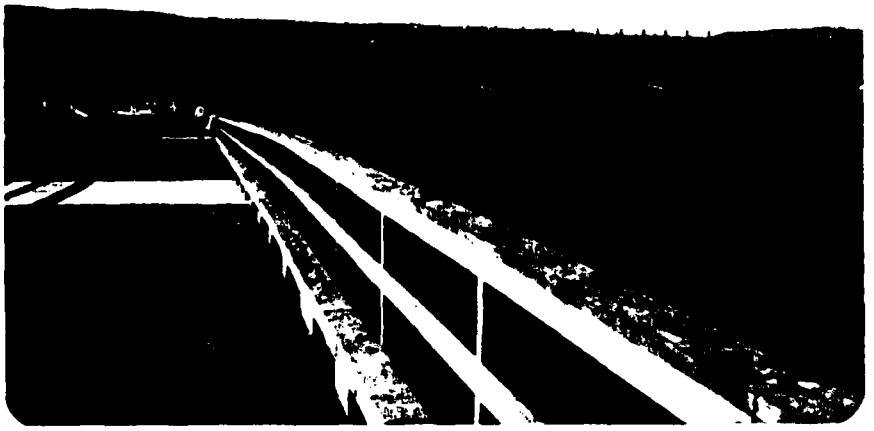
(See Table 1 and the accompanying piling plan)

3.6 TIME OF INSPECTION

The field testing was carried out during the week of September 29 to October 3, and the week of October 6, 1980.

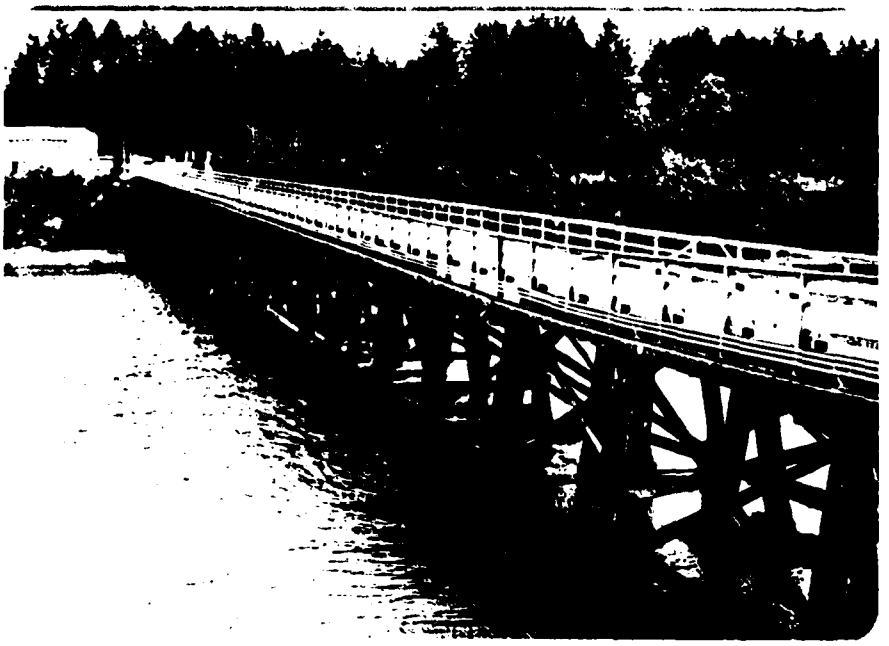
3.7 PERSONNEL ON PROJECT

Jerry Agi	-	Project Manager.
Erling Vegsund	-	Project Supervisor.
Herbert Lober	-	Engineering Technician/Draftsman.
Catherine McKinnon	-	Report preparation.



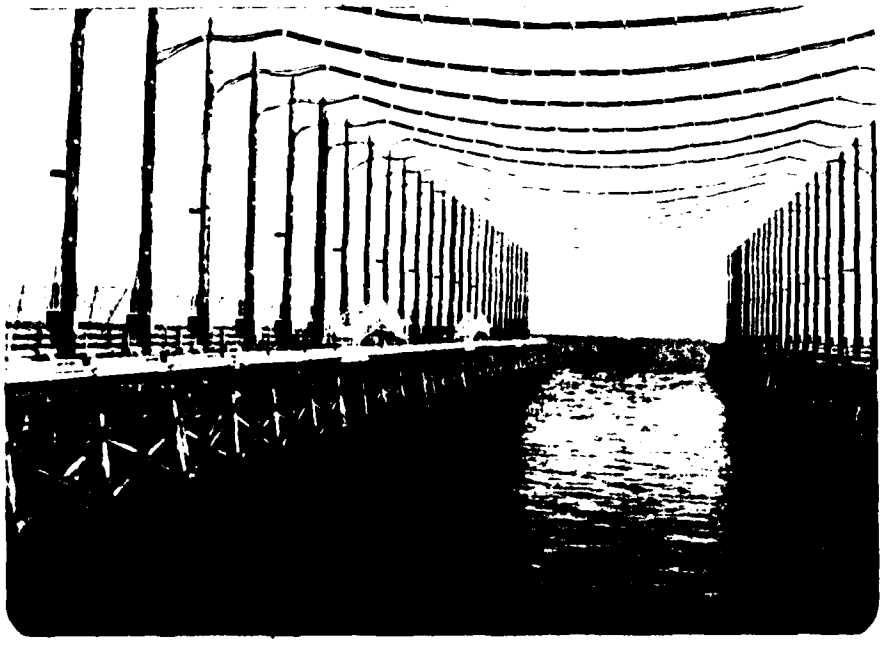
PHOTOGRAPH 1

Overview of the Deperming Pier at the Magnetic Silencing Facility, Bangor, Washington.



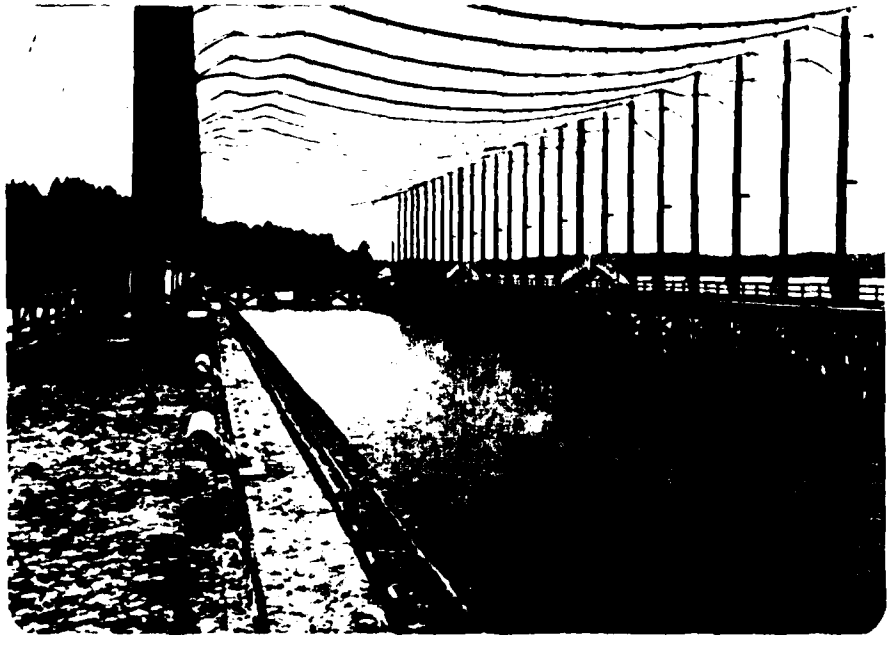
PHOTOGRAPH 2

Access Trestle at the Deperming Pier, Magnetic Silencing Facility, Bangor, Washington.



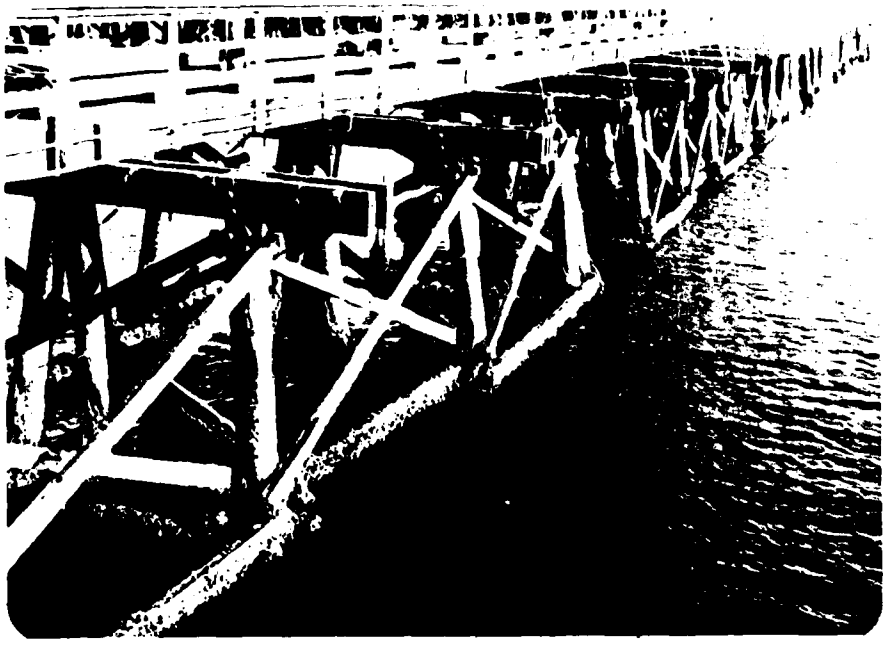
PHOTOGRAPH 3

East and West Piers of the Deperming Pier - looking north.



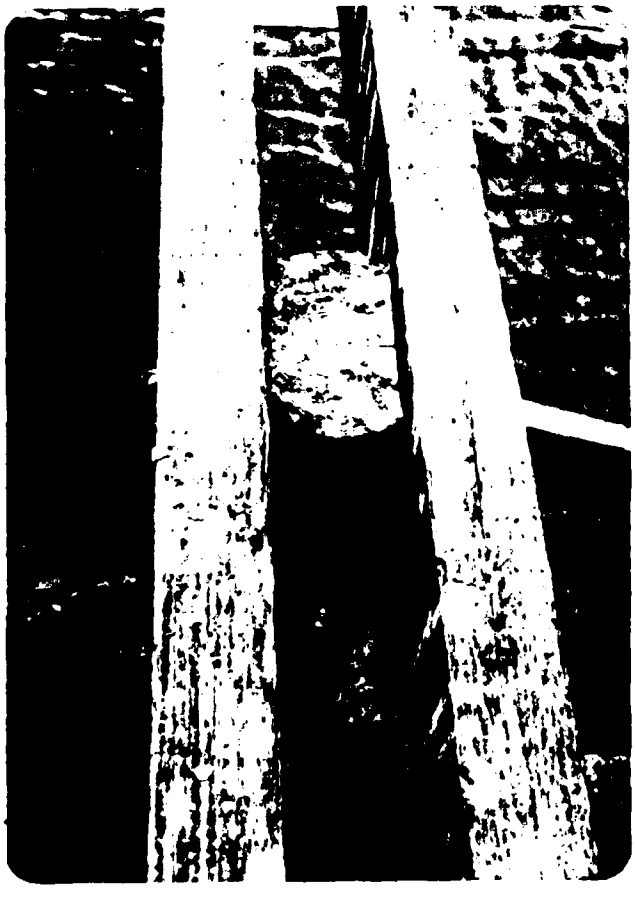
PHOTOGRAPH 4

East and West Piers of the Deperming Pier - looking south towards the Header Pier.



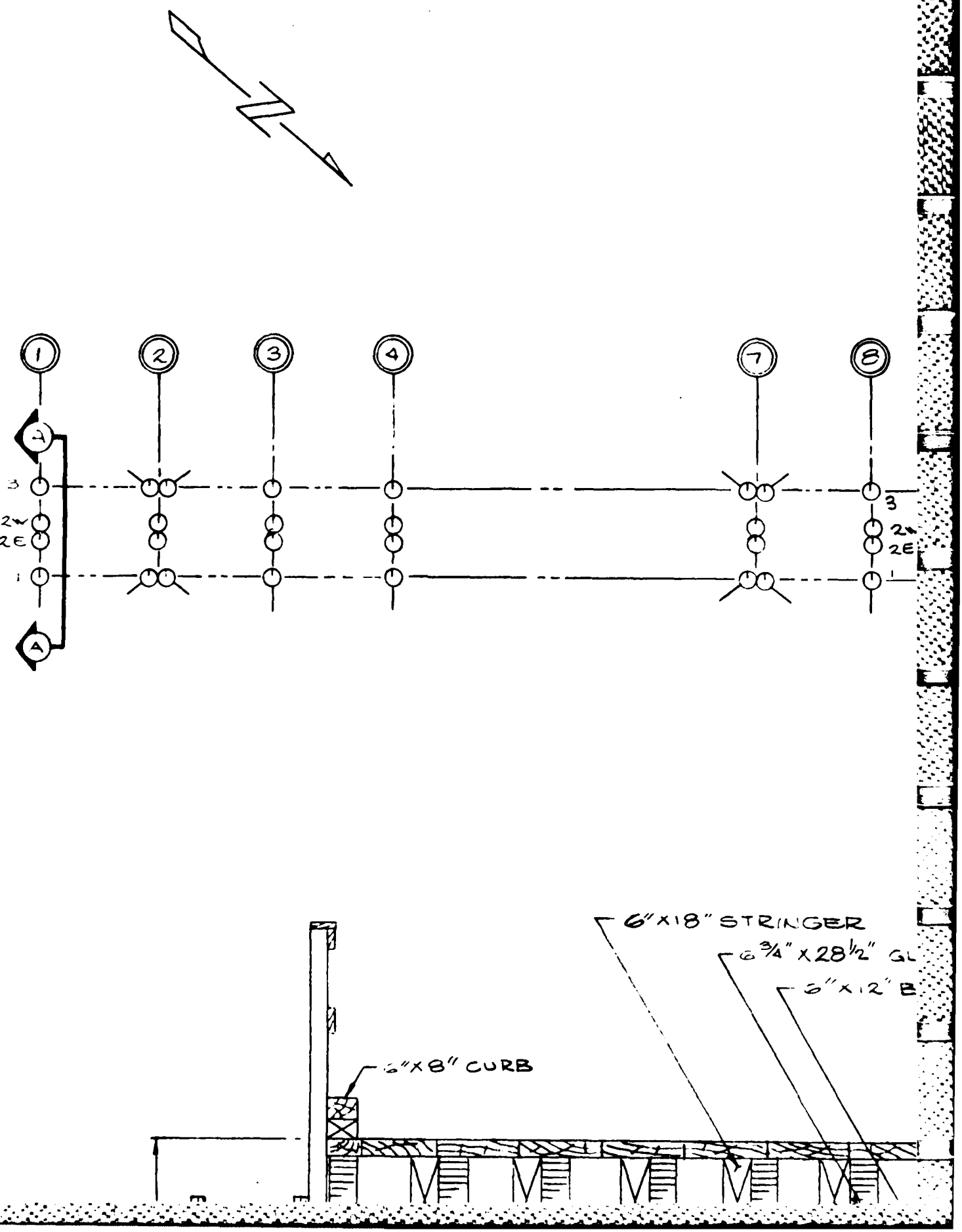
PHOTOGRAPH 5

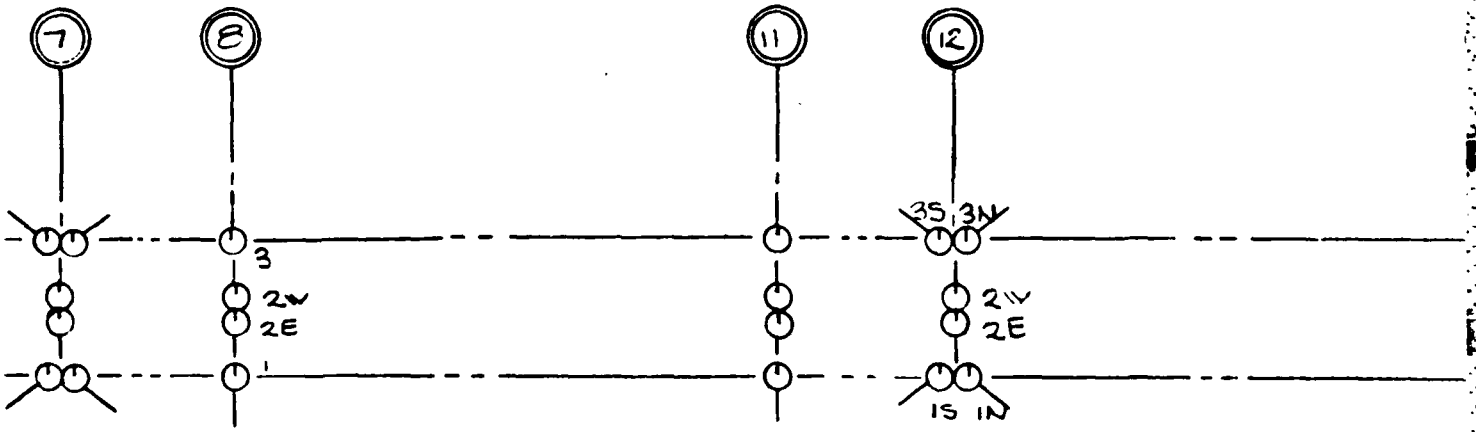
Typical timber brace framing of piling in the Deperming Pier.

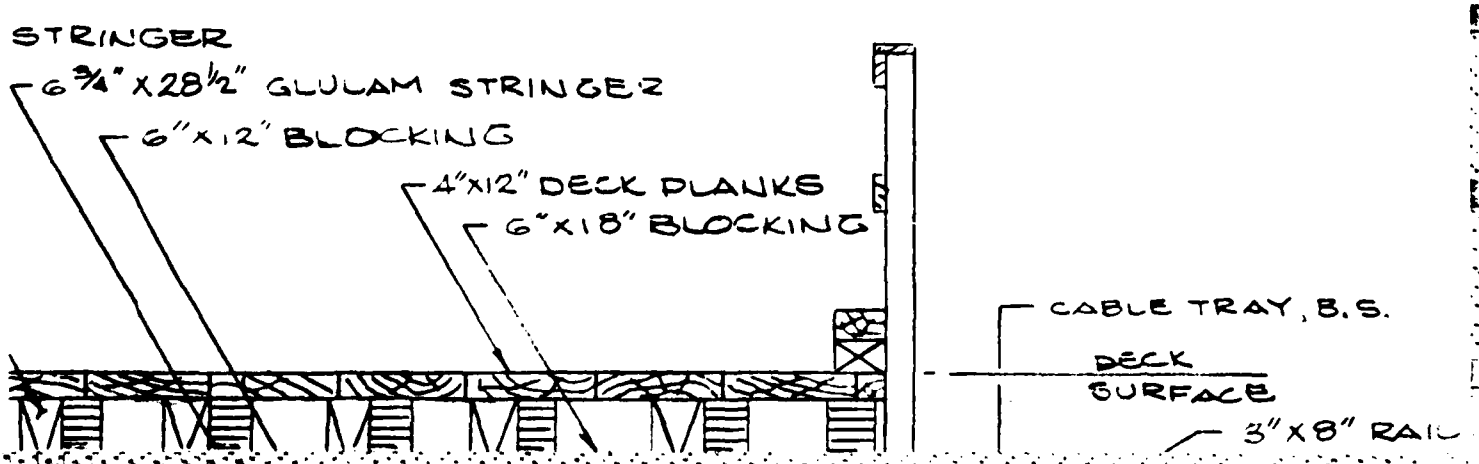


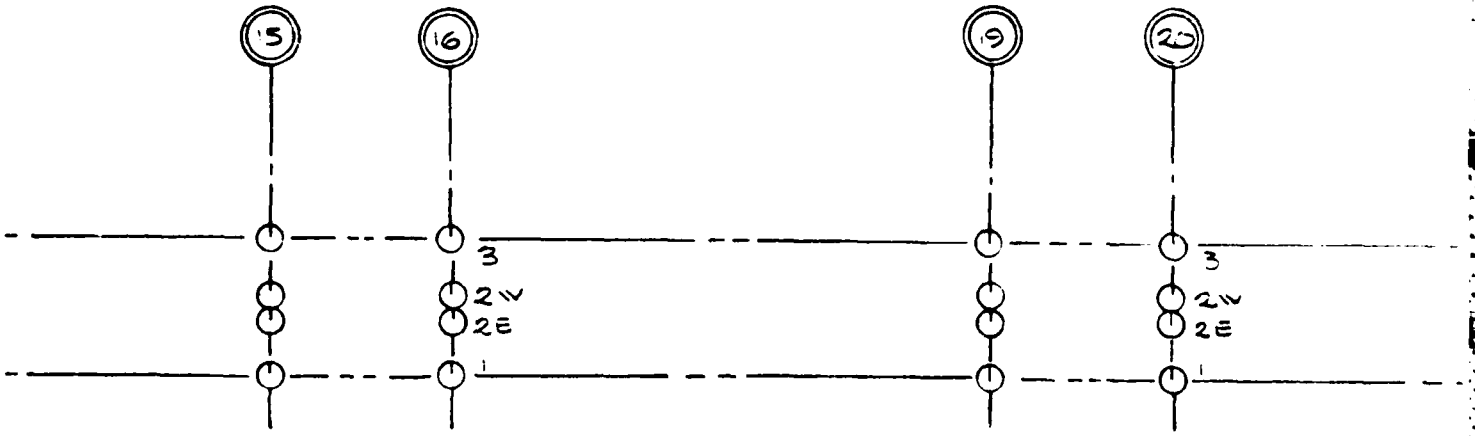
PHOTOGRAPH 6

Typical cap-pile arrangement at the Deperming Pier.


1
2
3
4
7
8
A
3
2W
2E
1
6"X18" STRINGER
6"X8" CURB


7
8
11
12
3S
3N
3
2W
2E
2W
2E
1S
1N


STRINGER
6 3/4" X 28 1/2" GLULAM STRINGER
6"X12" BLOCKING
4"X12" DECK PLANKS
6"X18" BLOCKING
CABLE TRAY, B.S.
DECK
SURFACE
3"X8" RAIL

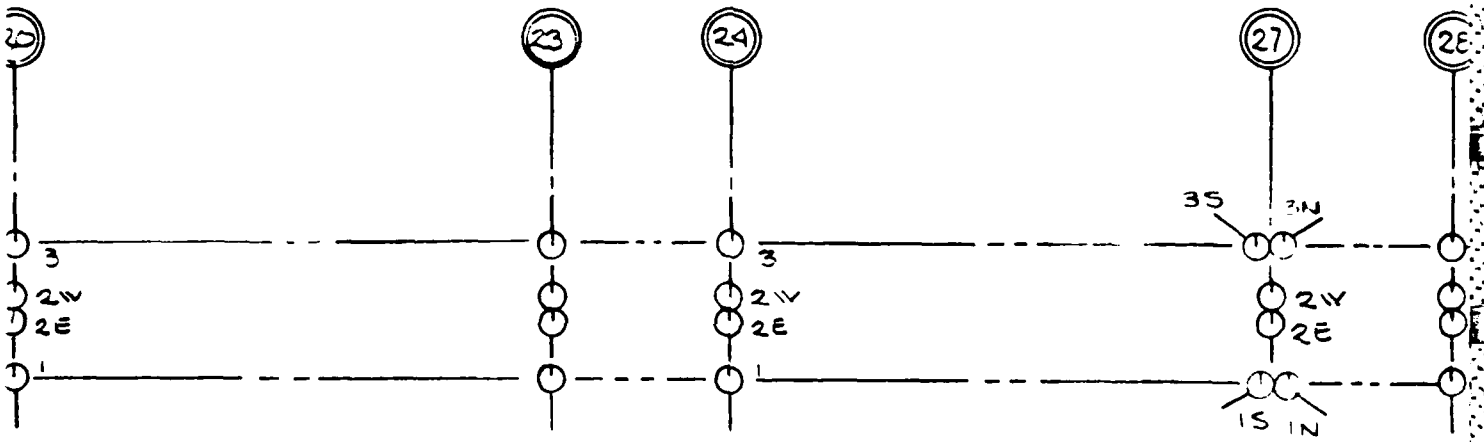


ACCESS TRESTLE PLAN AT PILETOP LE
SCALE - 1" = 20'

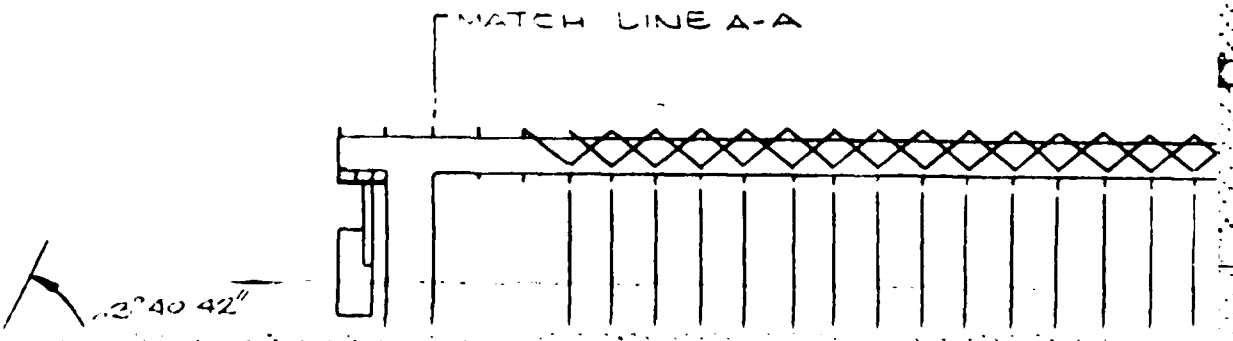
AY, B.S.

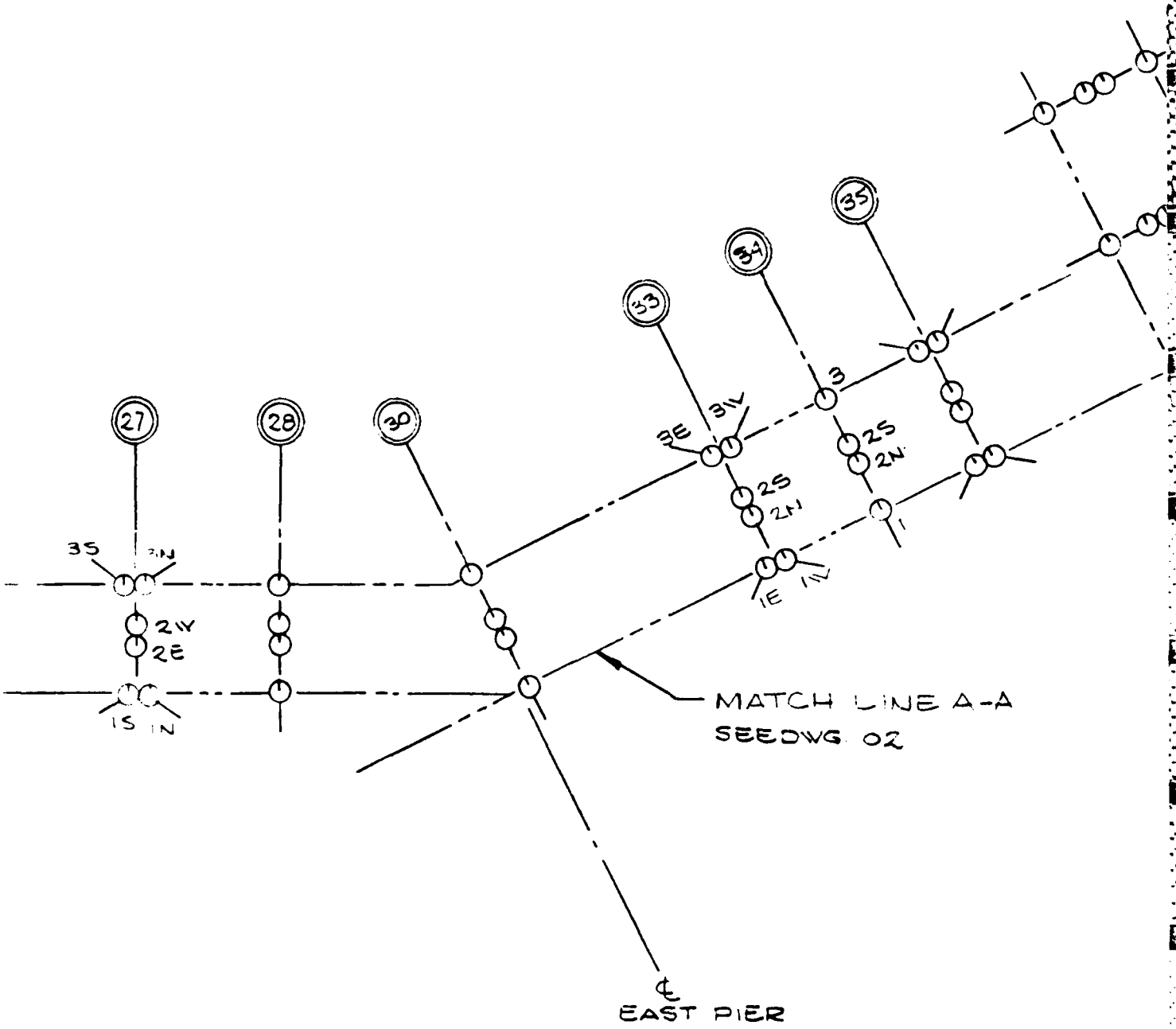
E

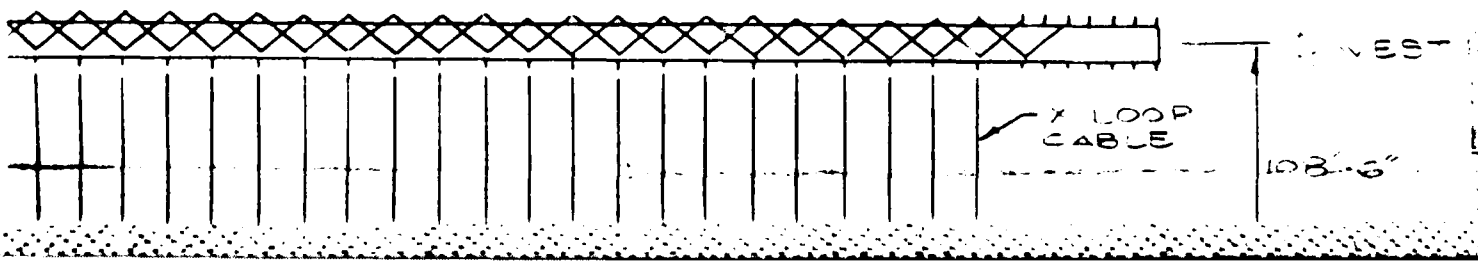
3"X8" RAIL

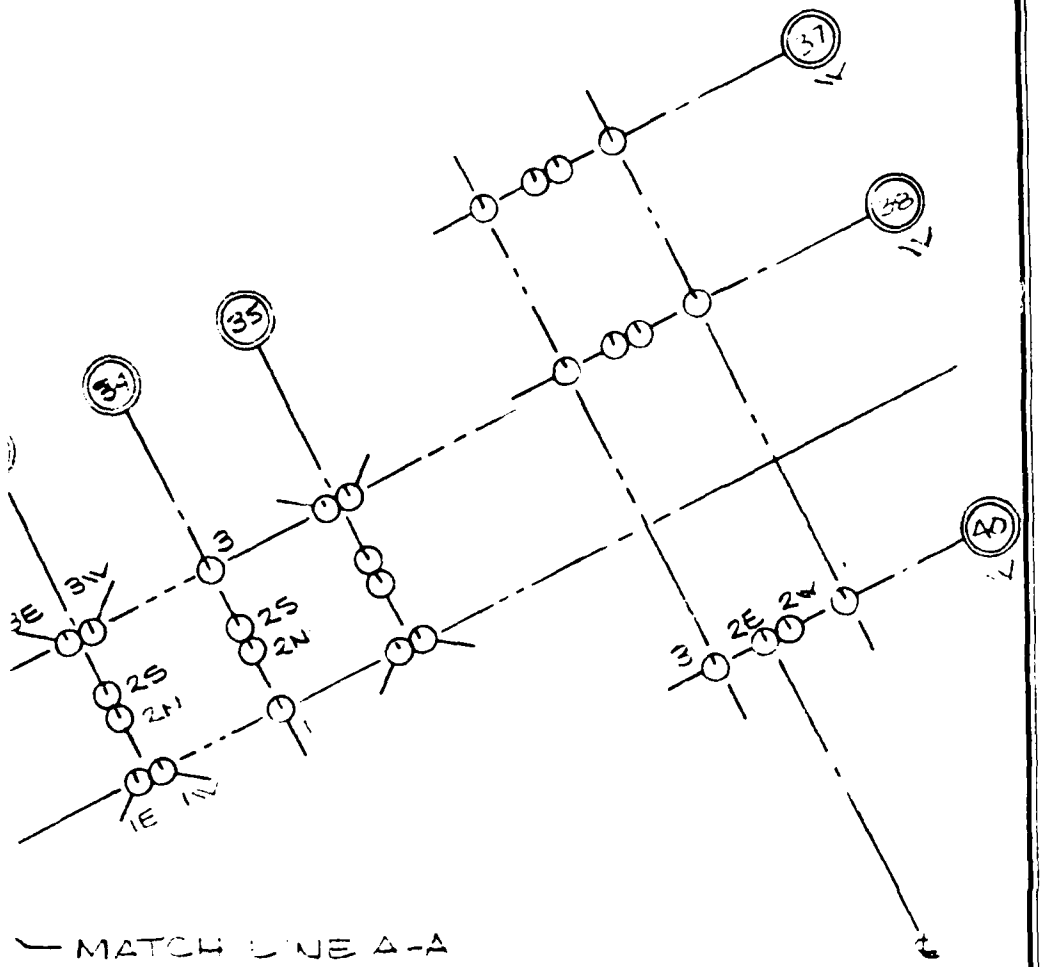


AT PILETOP LEVEL




27
28
30
33
34
35
3E
3W
3
2S
2N
2S
2N
1
1E
1W
3S
2N
2W
2E
1S
1N
MATCH LINE A-A
SEE DWG. 02
℄
EAST PIER

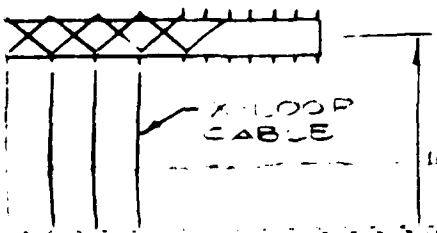

X LOOP
CABLE
10B'-6"

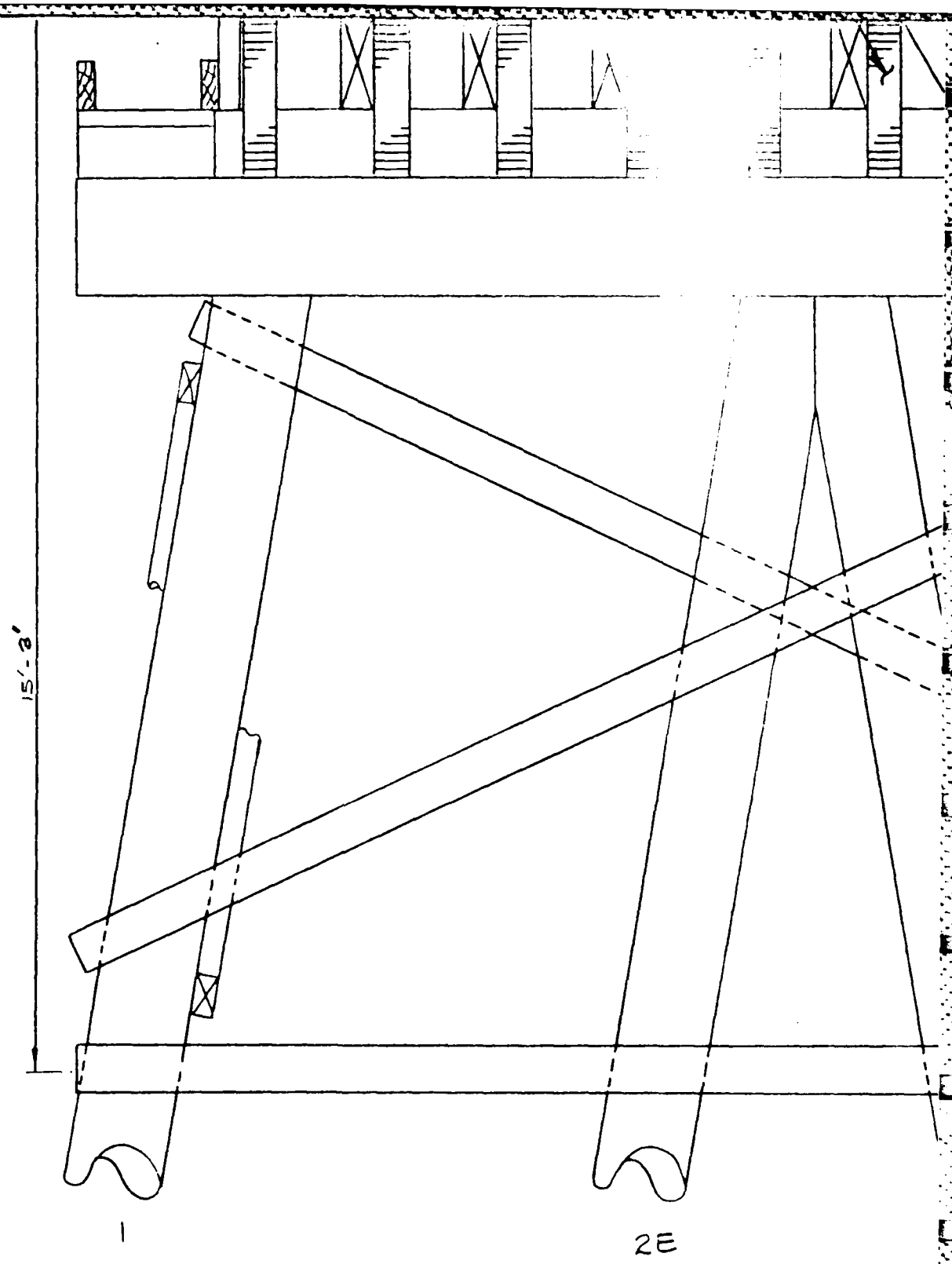


MATCH LINE A-A
SEE DWG 02

WEST PIER

ST PIER

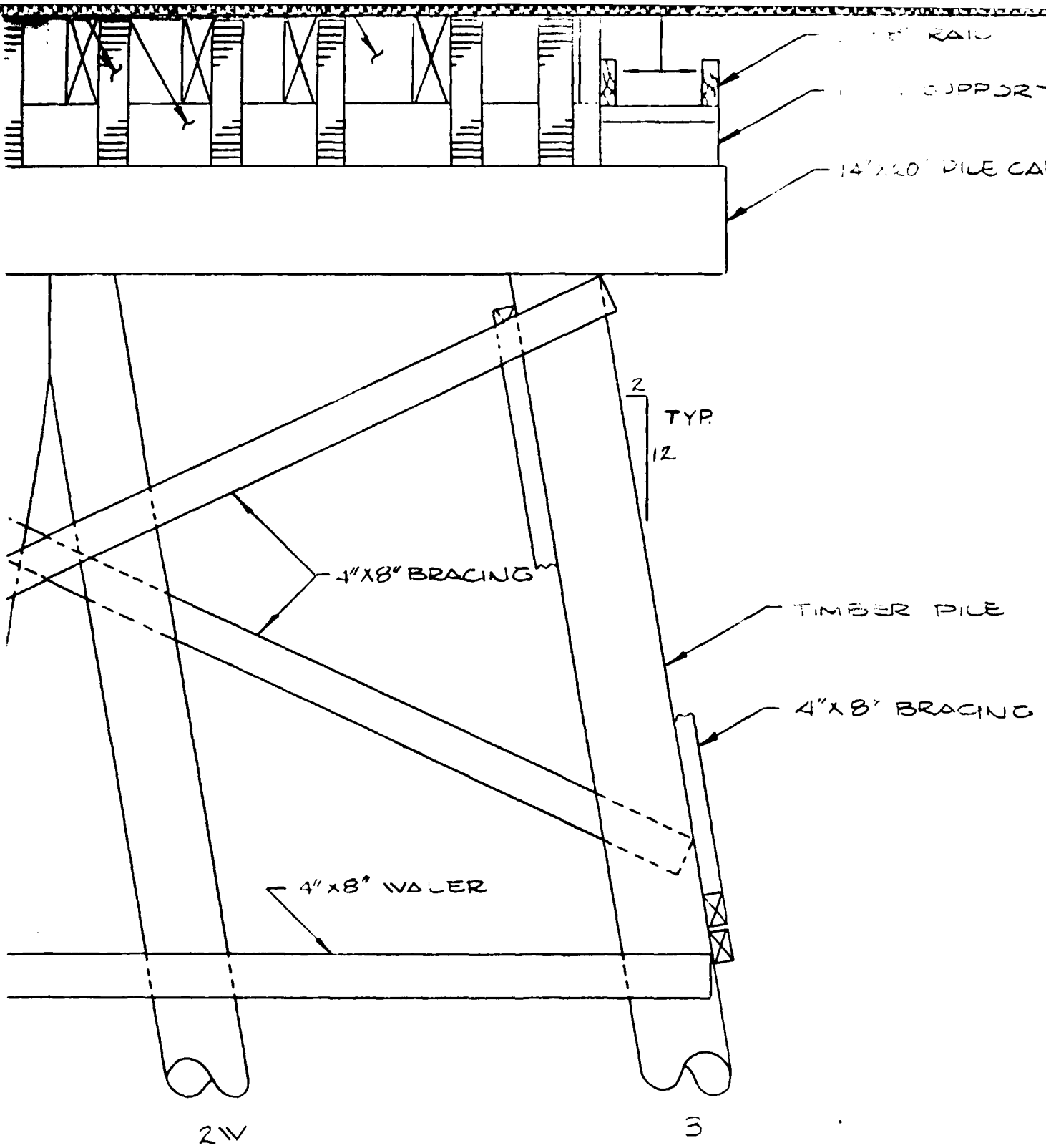




SECTION A-A

ACCESS TRESTLE AT

SCALE - 1:20



ON A-A

ESTLE AT BENT NO. 1

- 1:20

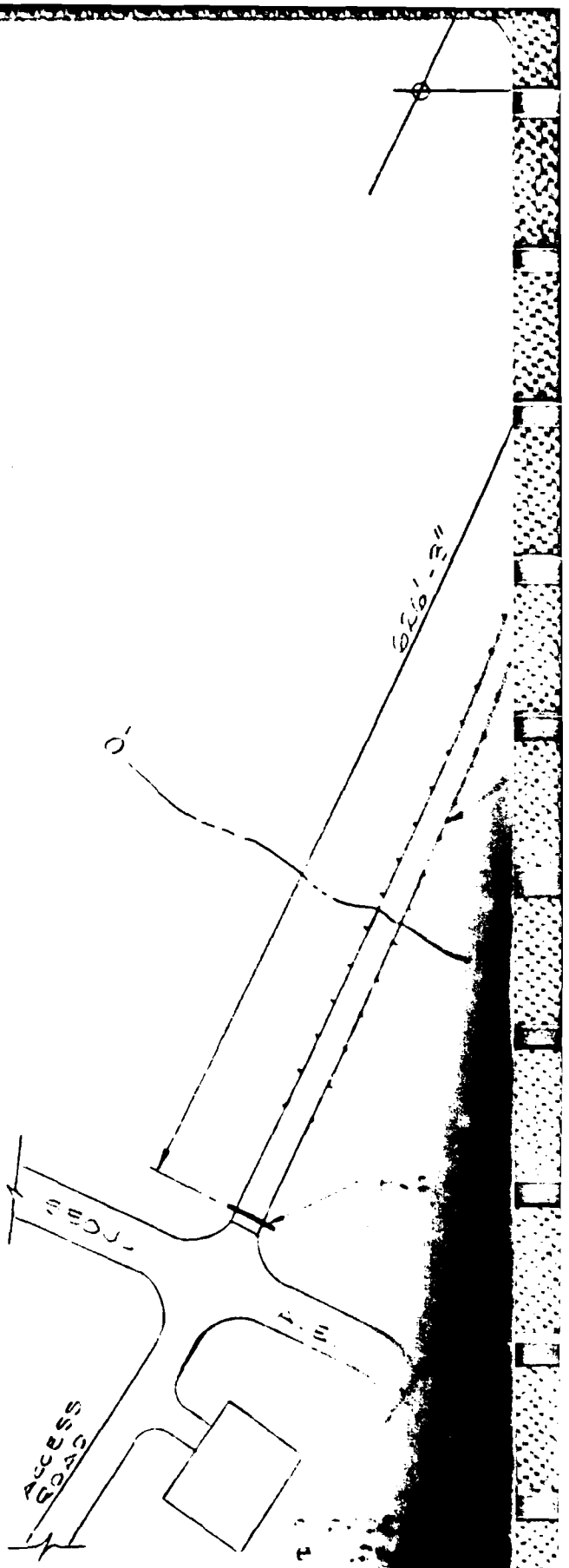
3"X8" RAIL

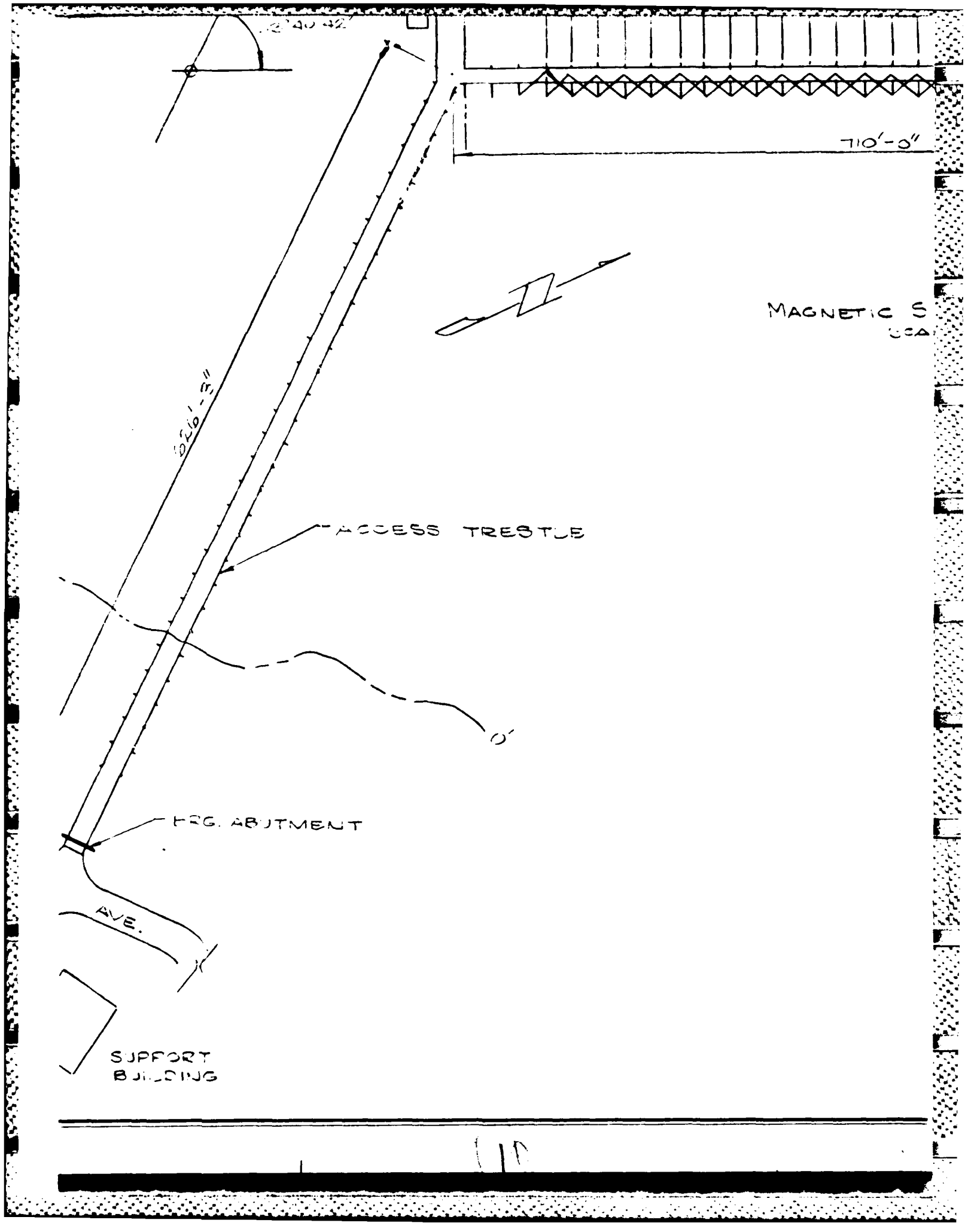
1"X14" SUPPORT BLOCK

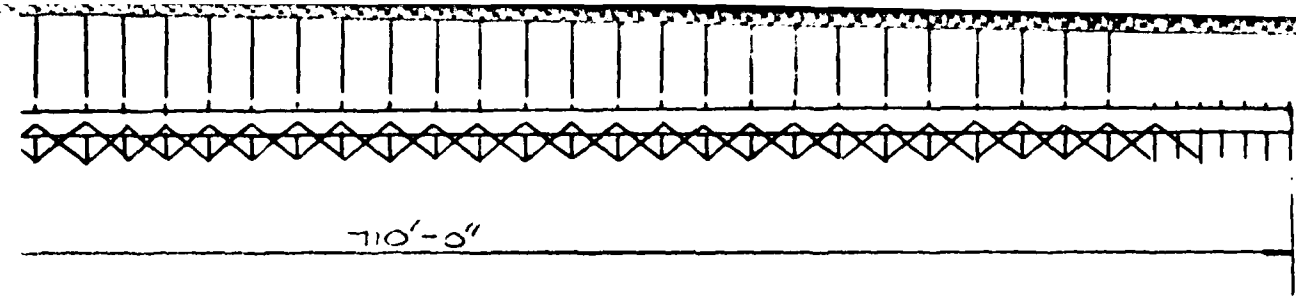
4"X20" PILE CAP

BER PILE

8' BRACING TYP.




710'-0"
MAGNETIC S
ACCESS TRESTLE
FRG. ABUTMENT
AVE.
SUPPORT
BUILDING



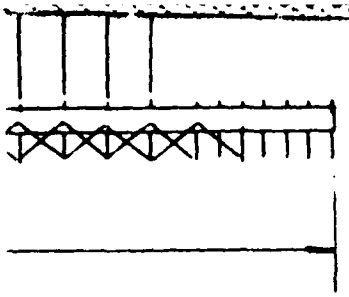
MAGNETIC SILENCING FACILITY PLAN
SCALE - 1" = 80'

EATT
100%
75%
50%
25%
0-25
2E PILE
(13) BENT

DRAWING NO. 01

J. AGI & ASSOCIATES CO. I
Suite 600, 1414 Alaskan Way, Seattle, W

SITE PLAN, ACCESS TRESTLE PLAN
SECTION SHOWING LOCATION AND
CONDITION OF INSPECTED PILING
BRACE CONFIGURATION IN MAGNE
SILENCING FACILITY
TRIDENT SUPPORT SITE BANGOR A
KEYPORT, WASHINGTON
CHESD[illegible] NAVFACENGCOM
REPORT NO. FPO-[illegible]-80 3)
CONTRACT NO. N62477 80-C-02



-LEGEND-

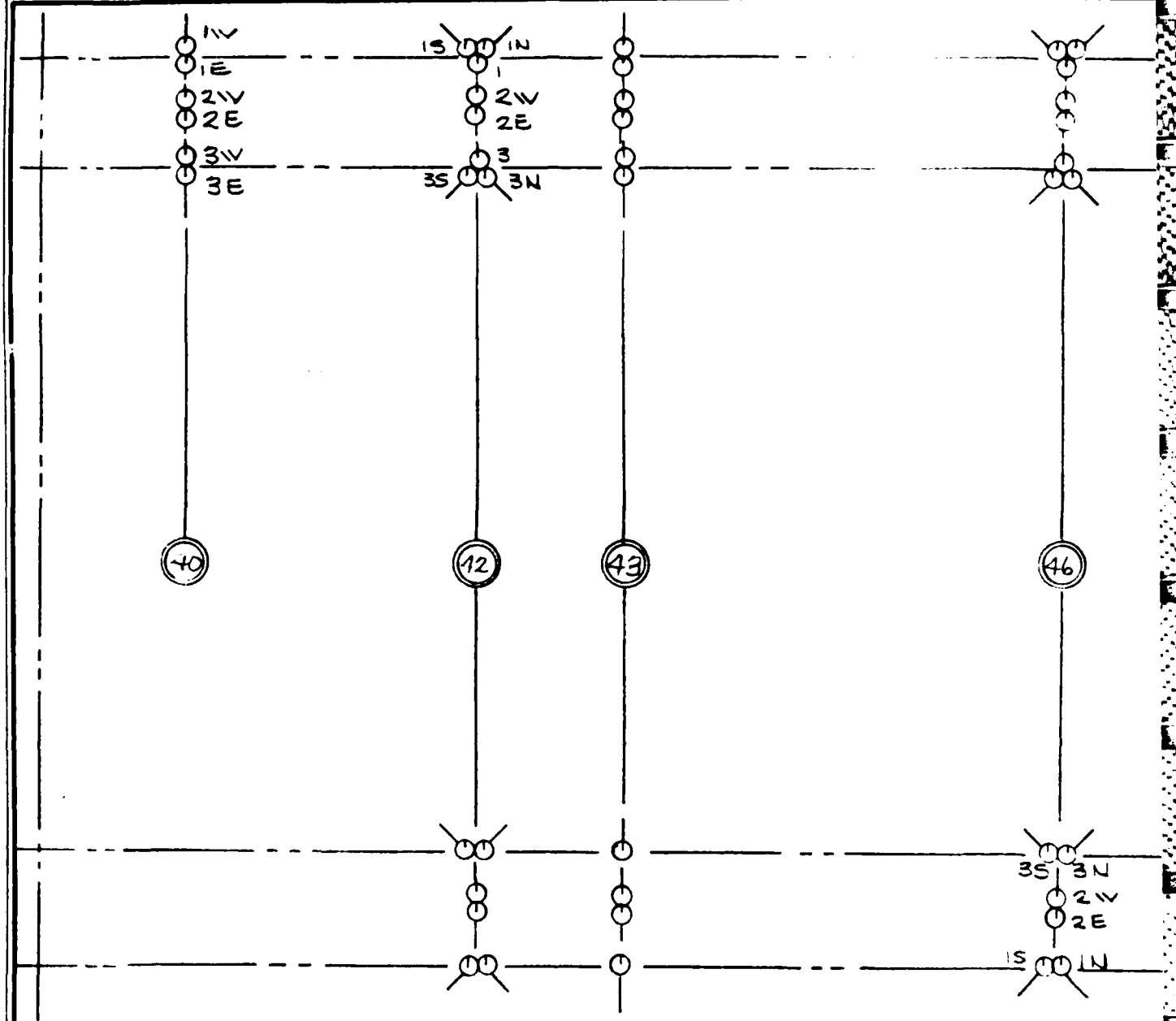
○	EATTER PILE
○	100% CROSS-SECTIONAL AREA
◔	75%
◑	50%
◕	25%
●	0-25%
2E	PILE DESIGNATION NO.
(12)	BENT NUMBER

-AN

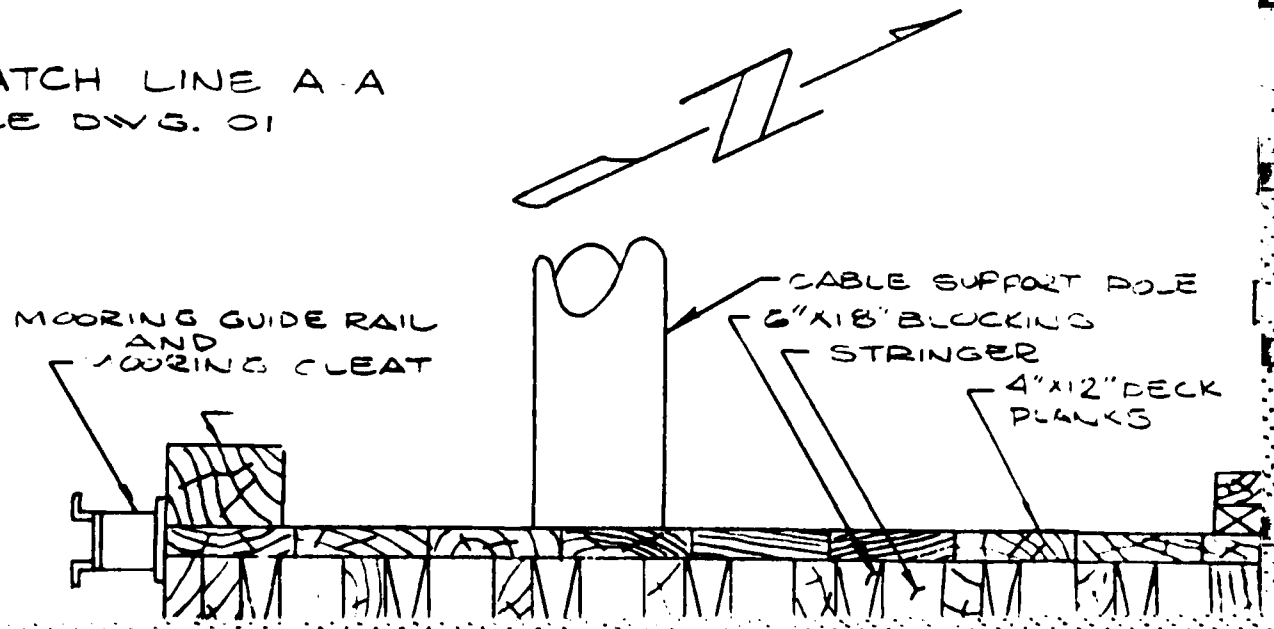
AWING NO. 01

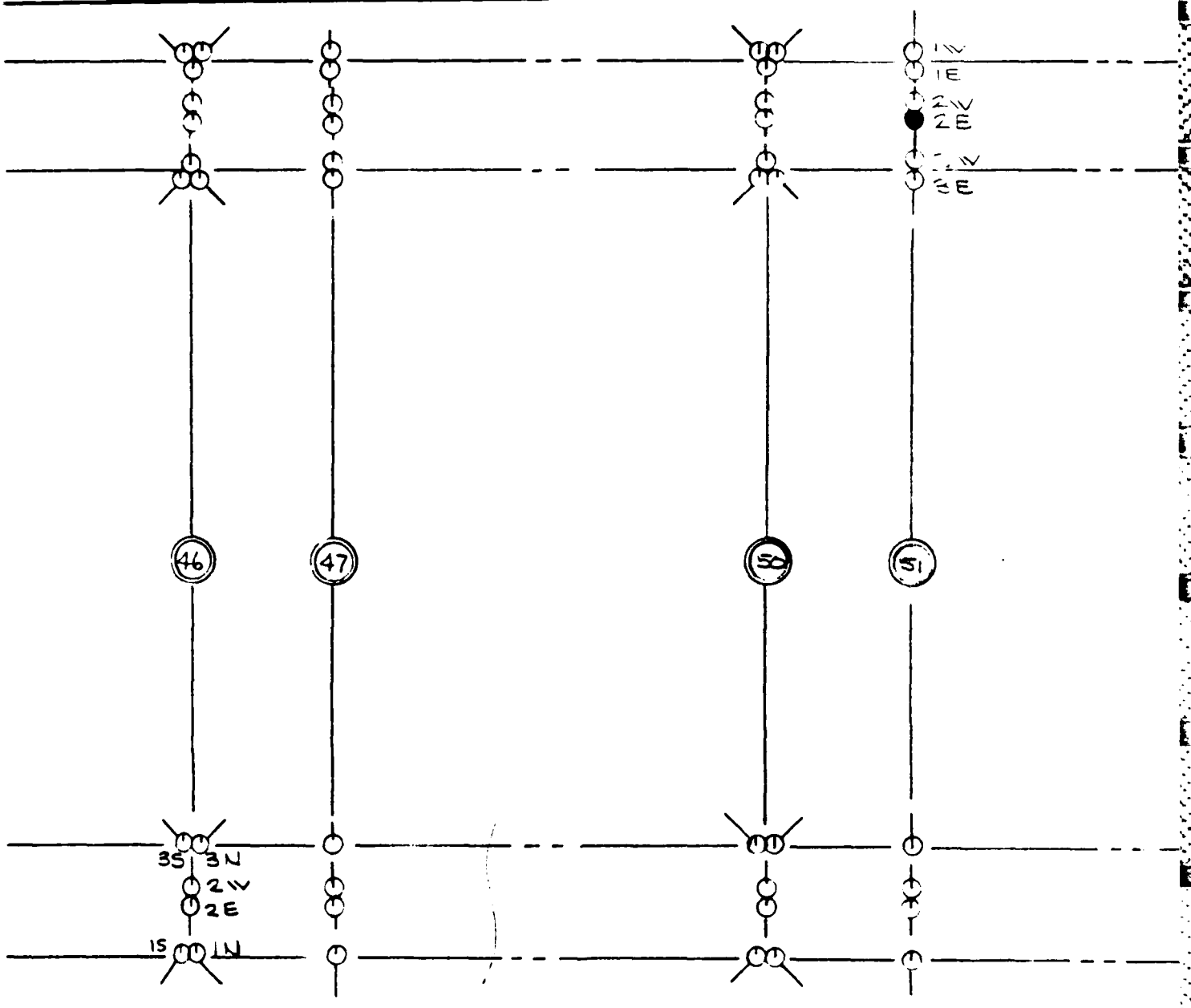
I & ASSOCIATES CO. LTD. te 600, 1414 Alaskan Way, Seattle, WA	SCALE AS SHOWN
	DRAWN
N, ACCESS TRESTLE PLAN AND SHOWING LOCATION AND ON OF INSPECTED PILING AND CONFIGURATION IN MAGNETIC NG FACILITY T SUPPORT SITE, BANGOR ANNEX KEYPORT, WASHINGTON NAVFACENGCOM ND. FPO-1-80(3) CT NO. N62477 80-C-0265	CHECKED
	APPROVED
	DATE 3 OCT 80
	PROJECT No 80-1-2-027

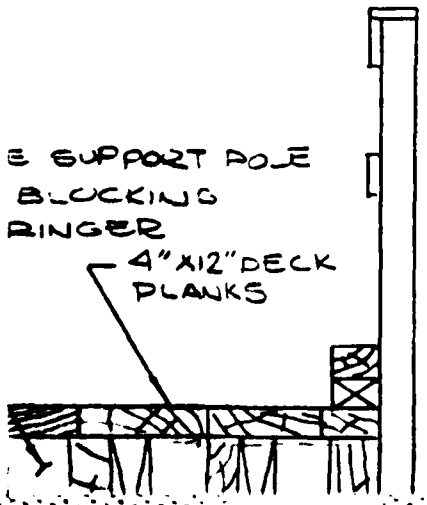
(1)

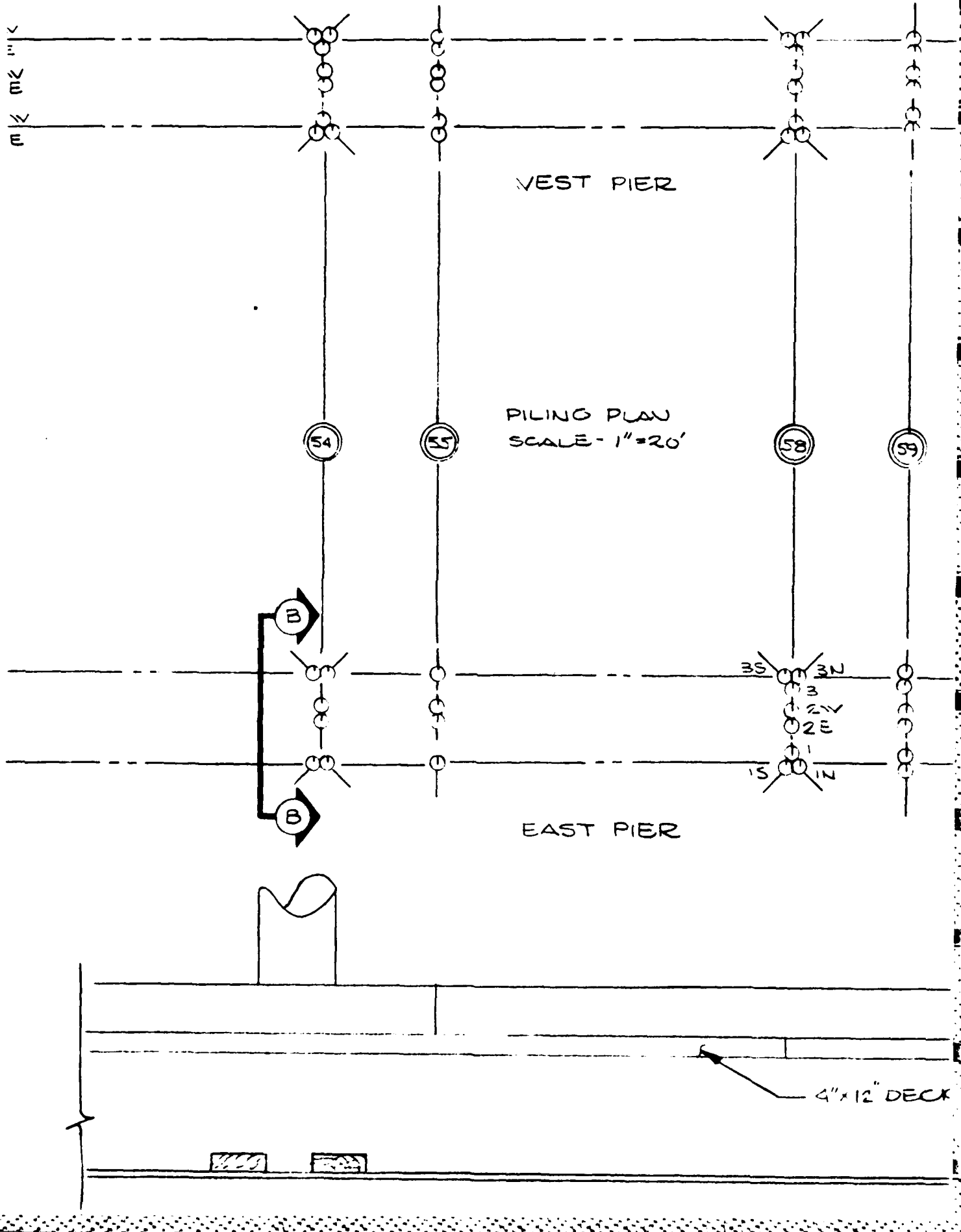


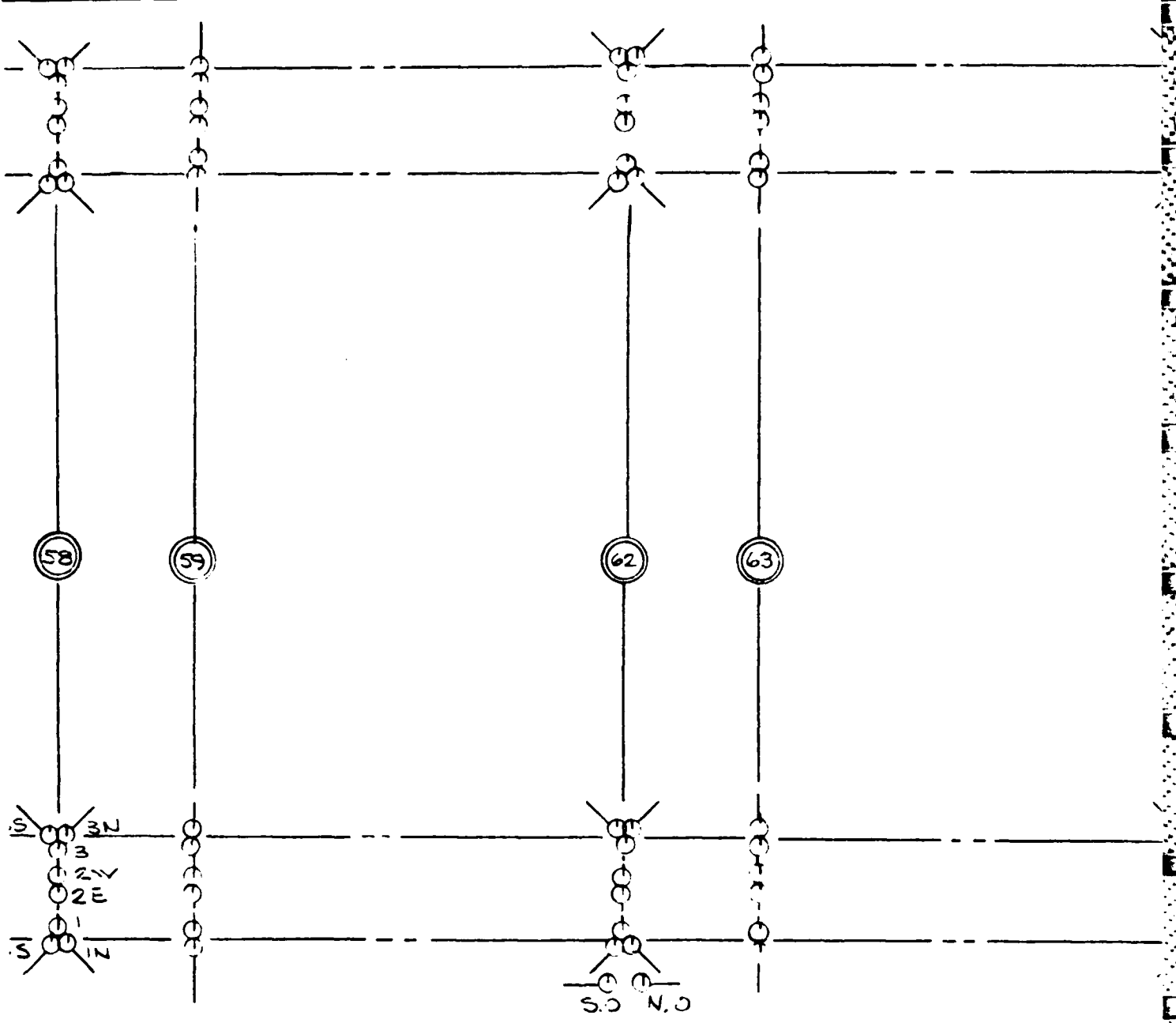
MATCH LINE A-A
SEE DWG. 01

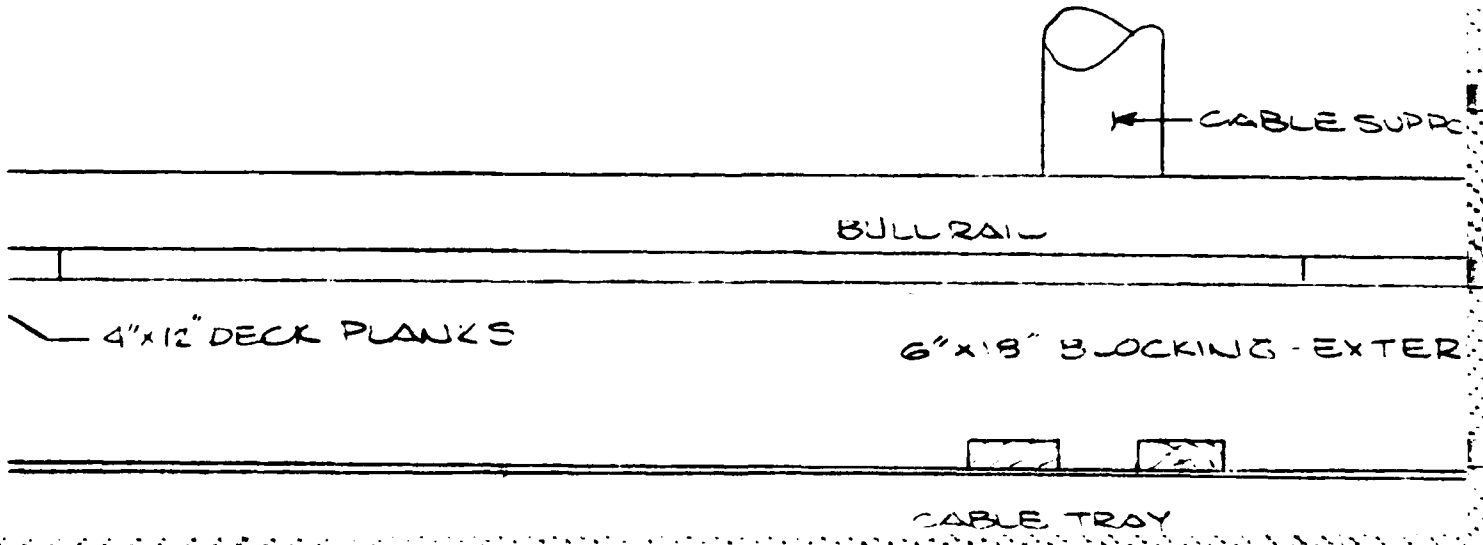


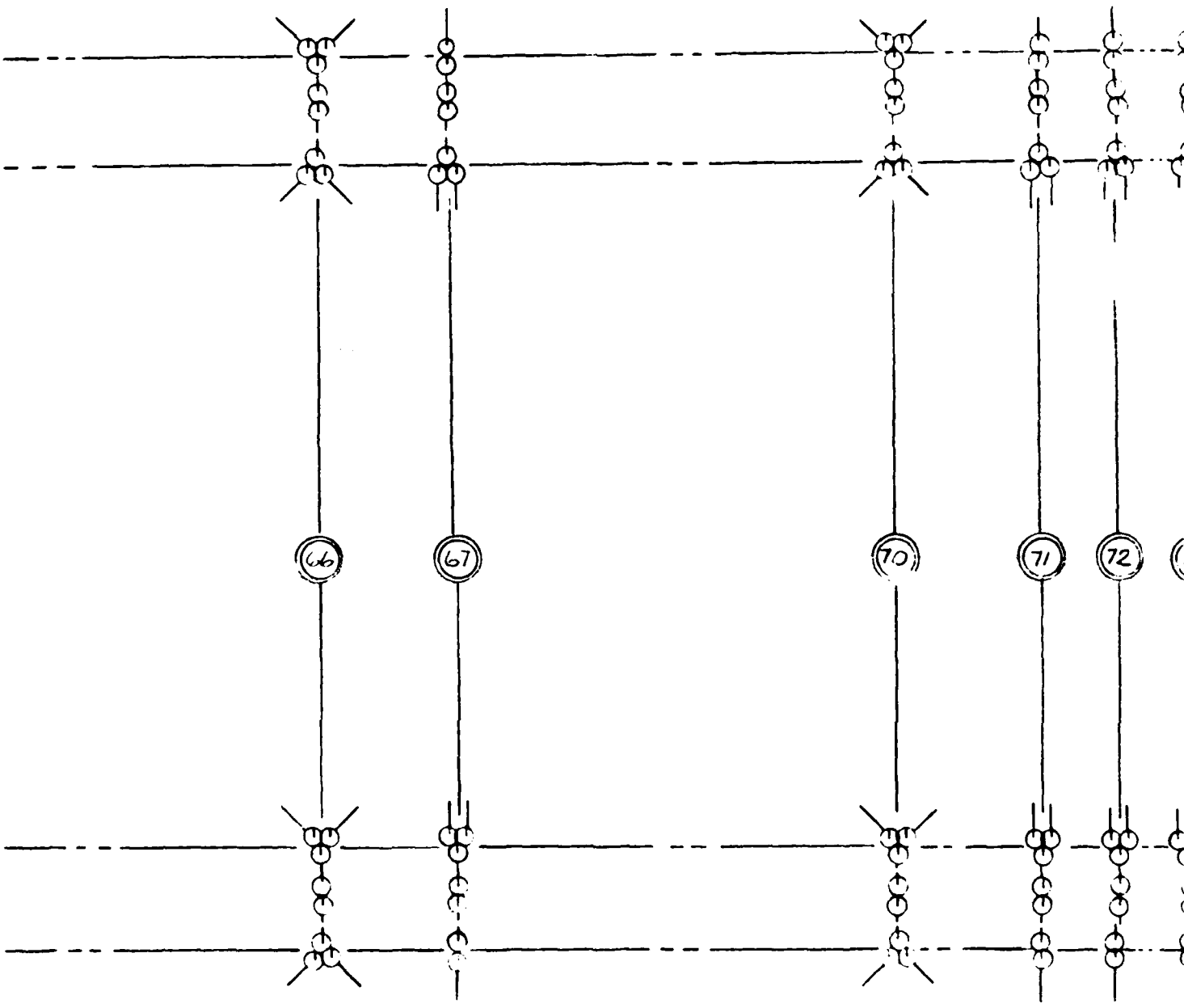

1W
1E
2W
2E
46
47
50
51
3S
3N
2W
2E
1S
1N


E SUPPORT POLE
BLOCKING
RINGER
4"X12" DECK
PLANKS


E ½
E
E ½
WEST PIER
PILING PLAN
SCALE - 1" = 20'
54
55
58
59
B
B
3S
3N
3
2½
2E
1
1S
1N
EAST PIER
4" x 12" DECK


58
59
62
63
3N
3
2W
2E
1
1S
1N
S.O
N.O

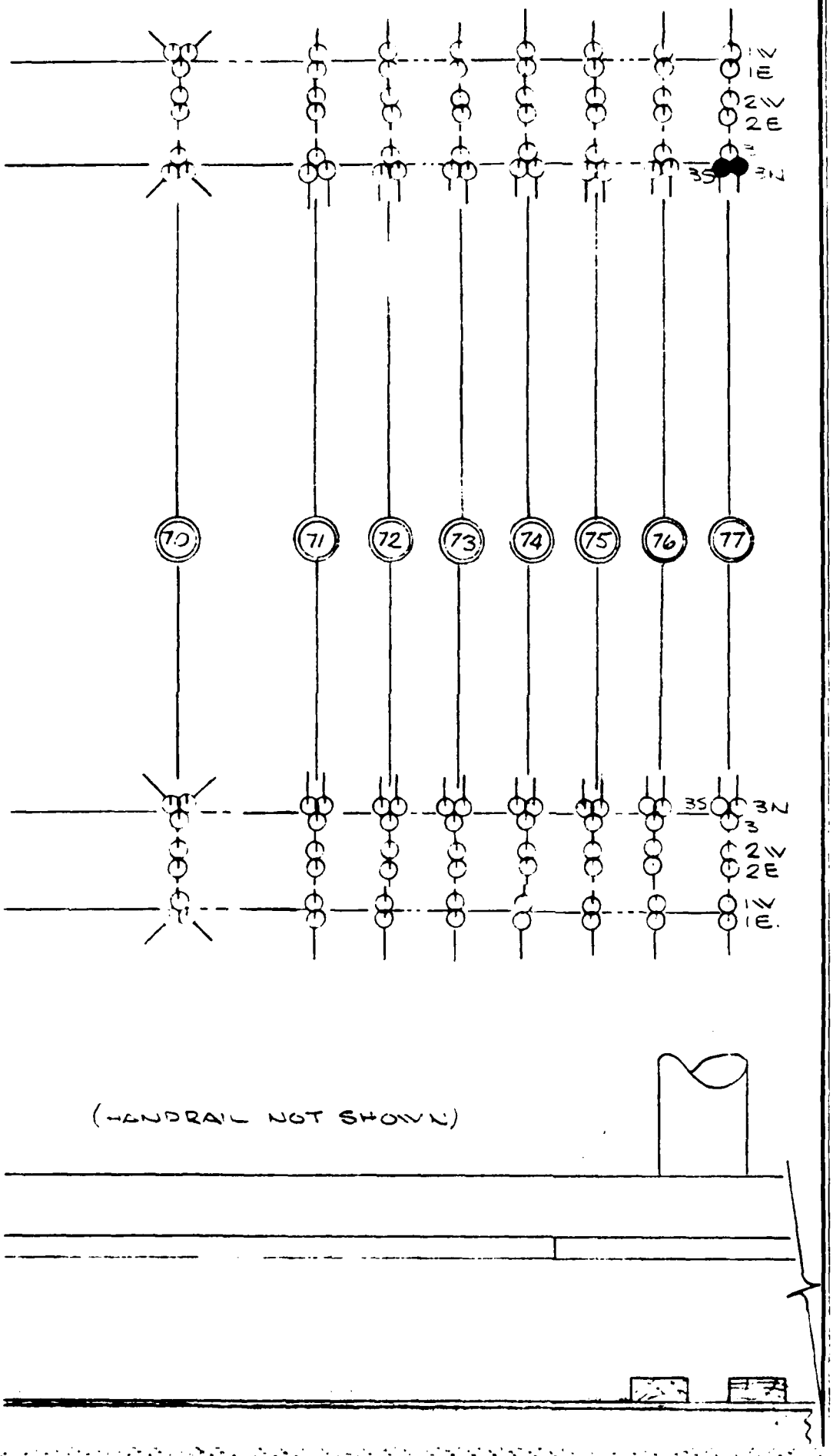

CABLE SUPPO
BULLRAIL
4"x12" DECK PLANKS
6"x18" BLOCKING - EXTER
CABLE TRAY



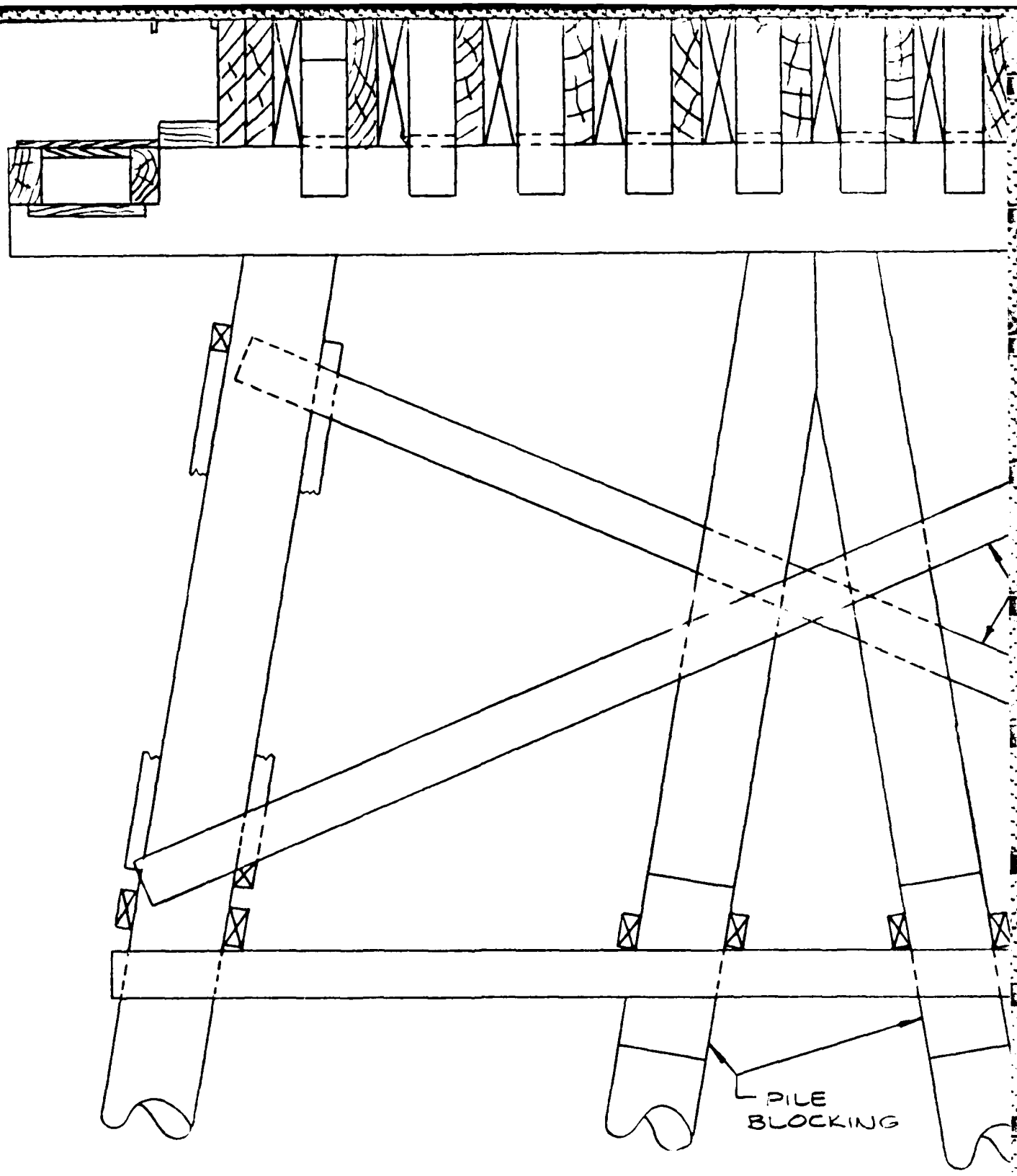
CABLE SUPPORT POLE

(HANDRAIL NOT SHOWN)

OCKING - EXTERIOR STRINGER



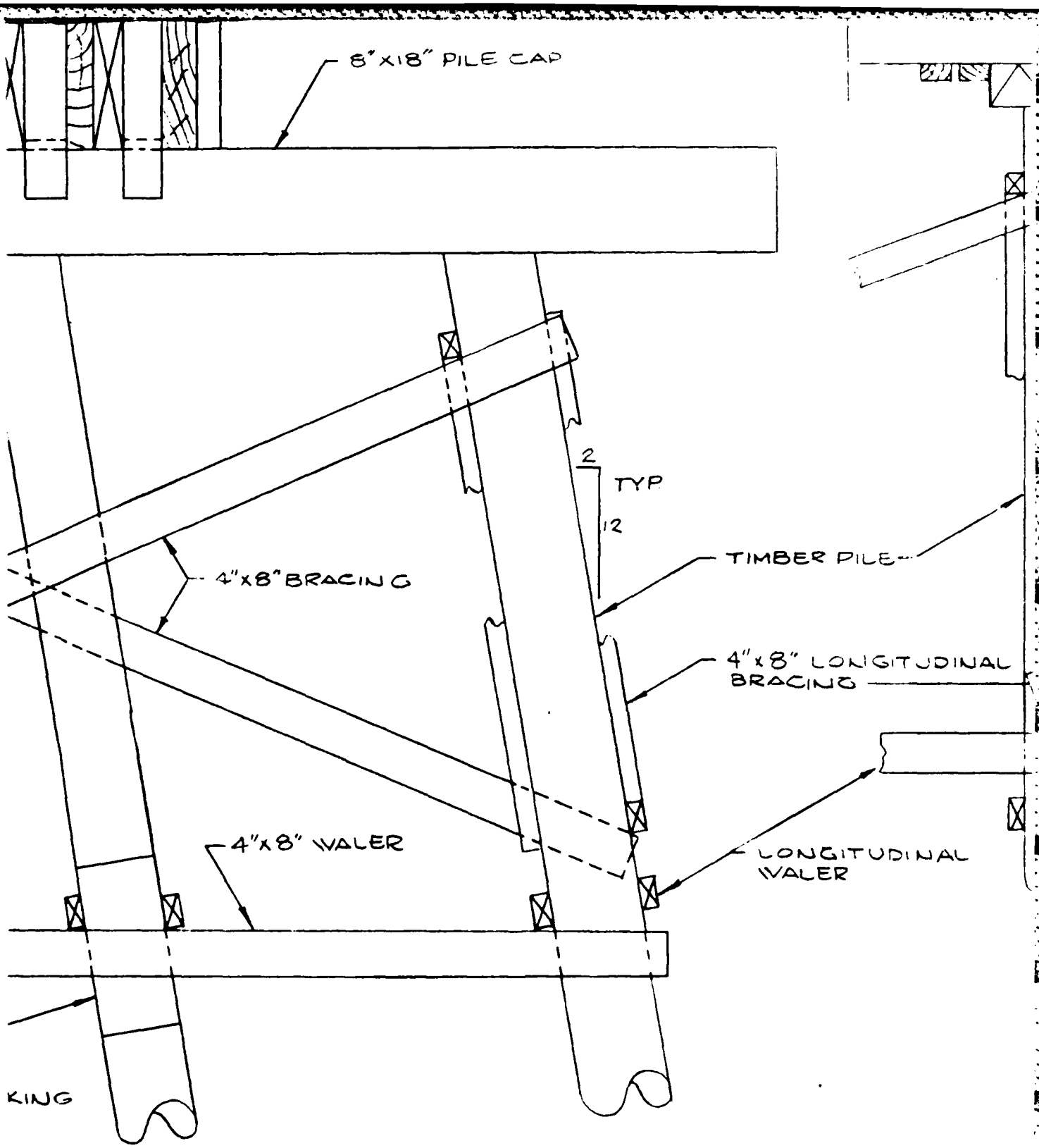
(HANDRAIL NOT SHOWN)



SECTION B-B

EAST PIER AT BENT 54

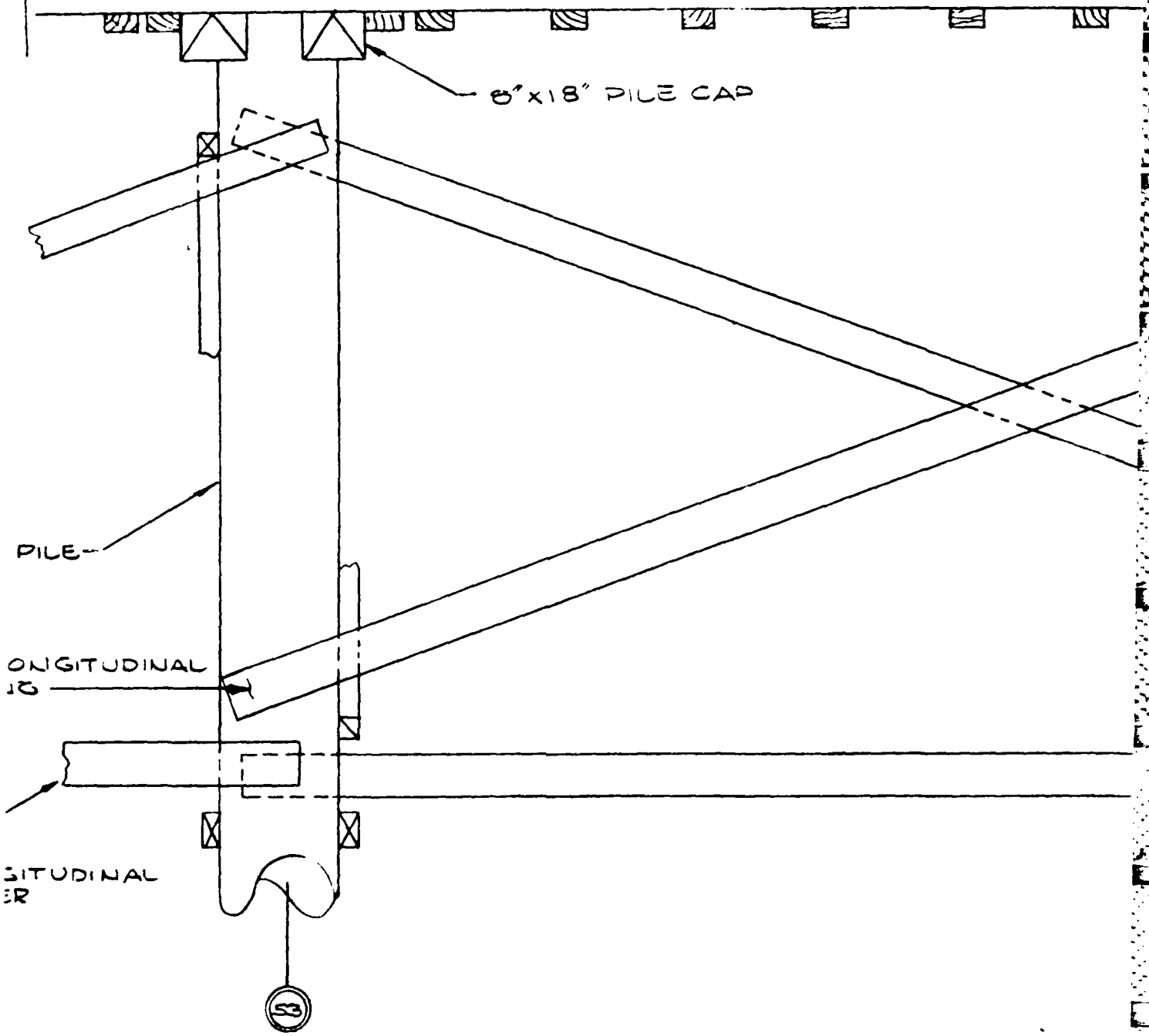
SCALE- 1:20



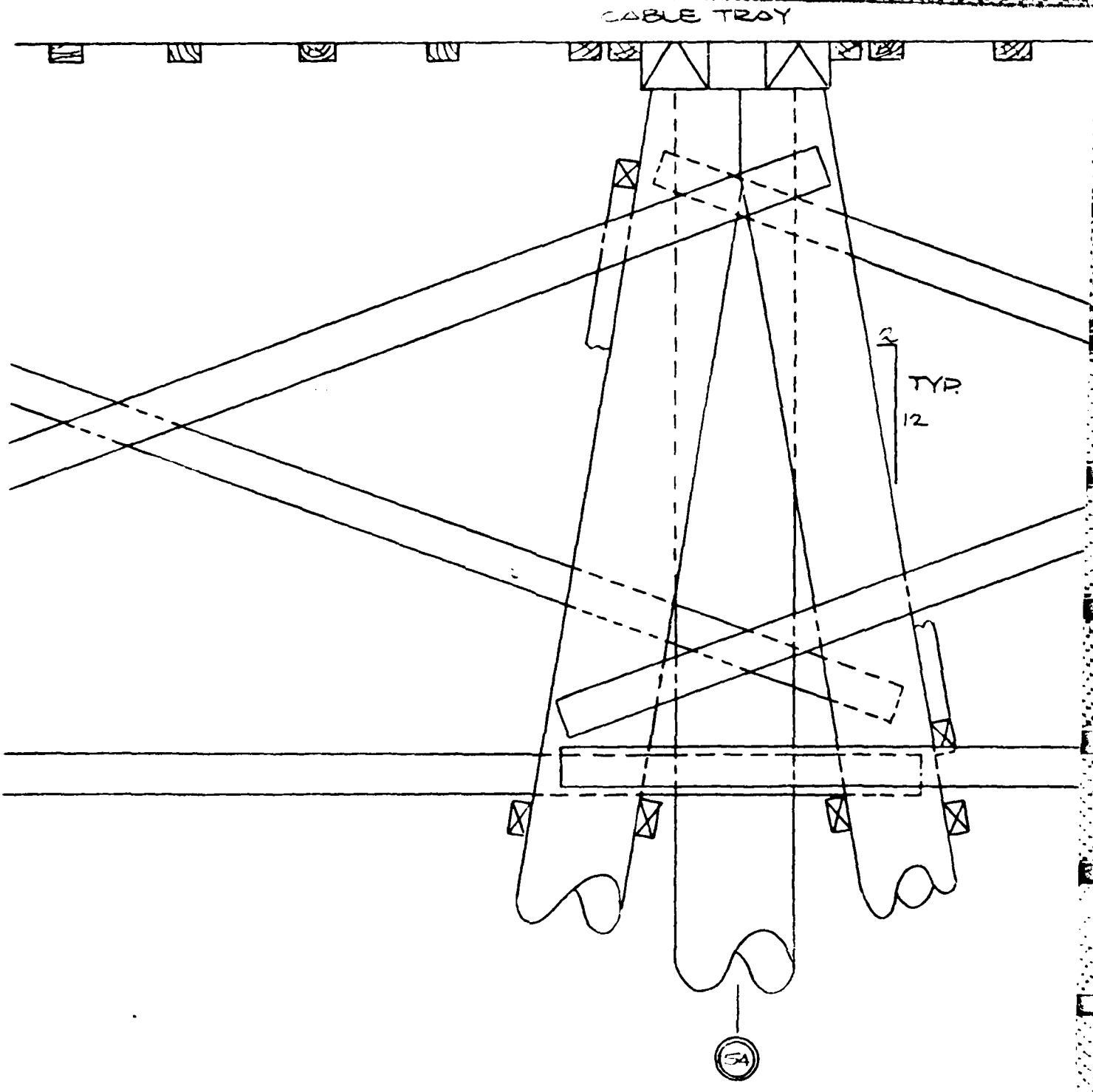
B-B

BENT 54

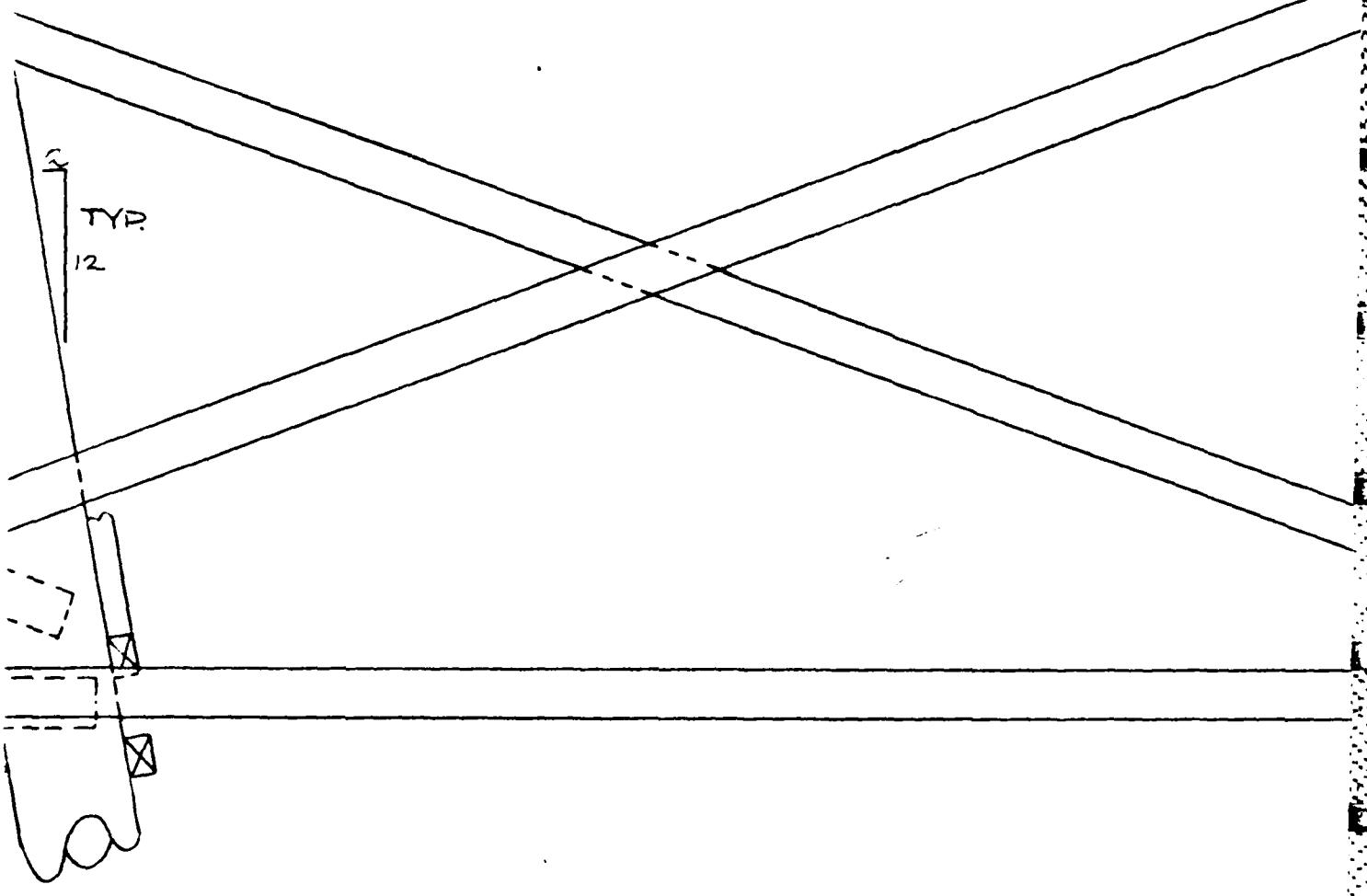
1:20



EAST PIER ELEVATI



PIER ELEVATION SHOWING PILING AND BRACE CONFIGURATION
SCALE- 1:20



DRAWING- 02

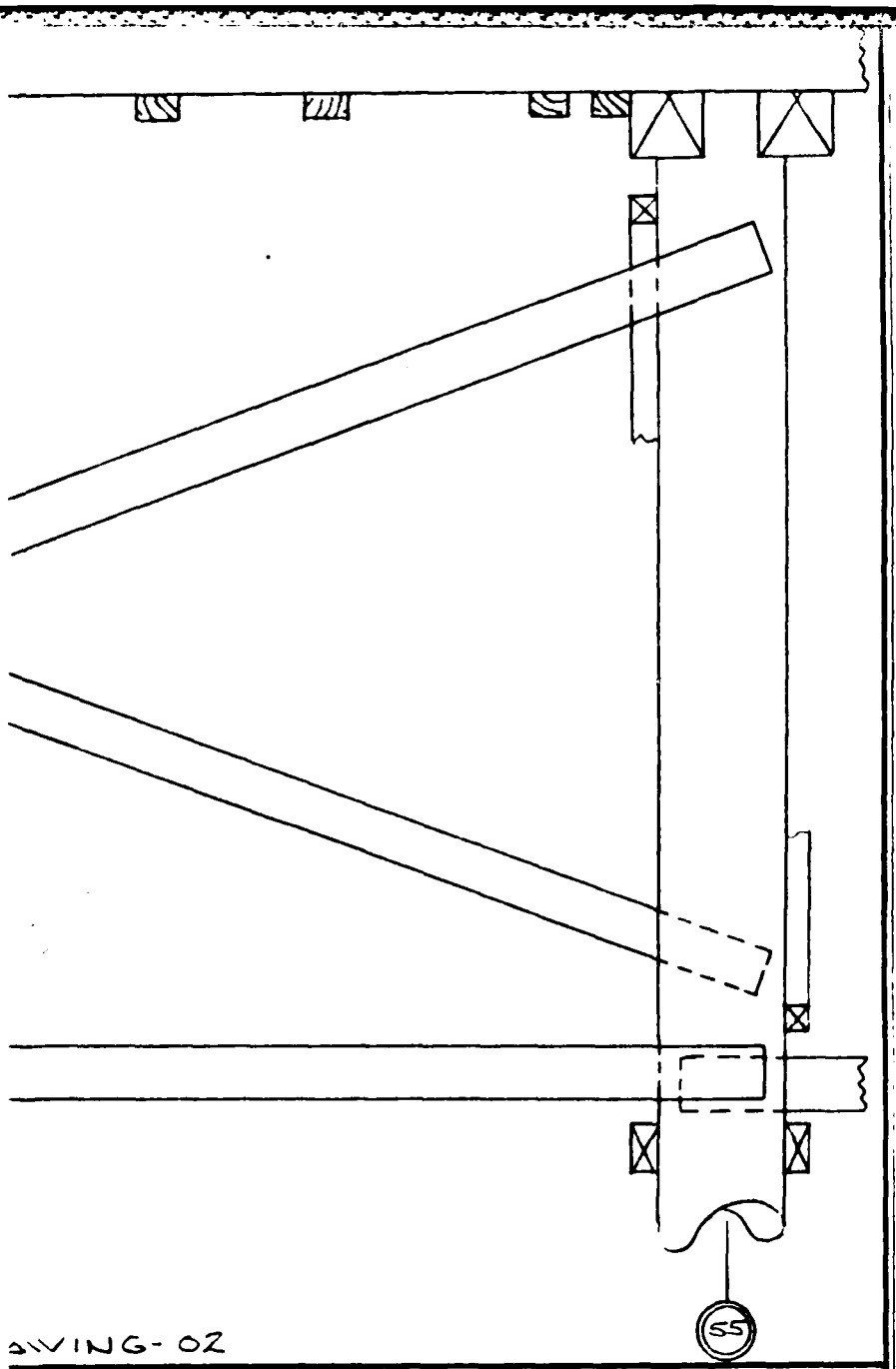
J. AGI & ASSOCIATES CO. LTD.
Suite 600, 1414 Alaskan Way, Seattle, WA

IGURATION

PILING PLAN AND ELEVATIONS SHOWING LOCATION AND CONDITION OF INSPECTED EAST AND WEST PIER PILING, AND BRACE CONFIGURATION.
MAGNETIC SILENCING FACILITY

TRIDENT SUPPORT SITE
BANGOR ANNEX, KEYPORT, WASHINGTON

CHESDIVNAVFACENGCOM
REPORT NO. FPO-1-80(13)
CONTRACT NO. N62477 80-C-0255



AWING- 02

SOCIATES CO. LTD.
Alaskan Way, Seattle, WA

ELEVATIONS SHOWING
CONDITION OF INSPECTED
IER PILING, AND BRACE
I.
ENCING FACILITY
RT SITE
, KEYPORT, WASHINGTON

NSCOM
-80(13)
62477 80-C-0265

SCALE	AS SHOWN
DRAWN	HL.
CHECKED	
APPROVED	
DATE	31 OCT 80
PROJECT No	80-1-2-027

SECTION 4 - STRUCTURAL CONDITION ASSESSMENT

4.1 OBSERVED INSPECTED CONDITION

The objective of this inspection was to establish the "base line" condition of the facility in general and the wood marine piles in particular. It was felt that a 60% sampling inspection, or 407 piles, would give a statistically valid projection of the overall condition of the piles. To achieve the best possible sampling results, pile bents throughout the structure, from Bent 1 of the Access Trestle to Bent 77 of the piers, were selected for testing. This type of sampling would give a representative sample of piles and ambient water conditions across the structure and throughout the length of the structure. (See Table 1 and accompanying piling plans for piles tested.)

An overview of the facility and surrounding areas indicated extensive marine life at the pier. Fish, shellfish and marine fouling growth was found in abundant quantities. Crab, flounder, ratfish, salmon, perch and rockcod were observed under the pier. The bottom contained varieties of starfish and marine growth (see Photograph 12).

The piling contained a moderate amount of marine fouling growth. In the intertidal zone, from MHW to -5', the piles contained barnacle, mussel and hydroid growth ranging in thickness from 1½" to 3". (See Photographs 7 to 11 and fouling profile drawing, Figure 5.)
From -5' to mudline the fouling was much more sparse and rarely exceeds one inch in thickness.

The overall condition of the facility was found to be excellent. The condition of the 407 examined piles was found to be excellent with no indication of marine borer or fungal damage. The exception to this was three piles in the West Pier, 51W-2E, 77W-3N and 77W-3S. Two of these piles have sustained extensive mechanical damage (see Figures 6, 7 and 8 and Photographs 13 to 16). Pile 77W-3N is severed at 27 feet below the cap with the two pile stubs being out of alignment by about two feet. Pile 77W-3S has broken with the rupture extending to about one-half of the pile diameter (see Photograph 17).

PHOTOGRAPH 7

Typical marine fouling found in the intertidal zone. Upper part of pile cleaned of fouling.

PHOTOGRAPH 8

Underwater section of pile cleaned of fouling. Note uncleaned pile on right.

PHOTOGRAPH 9

Typical barnacle and mussel fouling on the piles in the intertidal zone.

PHOTOGRAPH 10

Typical fouling found on the pile in the 0' to -30' zone. Hydroid growth, sponges and some barnacles and mussels observed.

PHOTOGRAPH 11

Fouling on piling in the -30' to -40' zone. Photograph also shows cable support timbers.

PHOTOGRAPH 12

Photograph shows pile at mudline area. Fouling on pile includes barnacles and mussels. Bottom covered with mussel shells and some starfish.

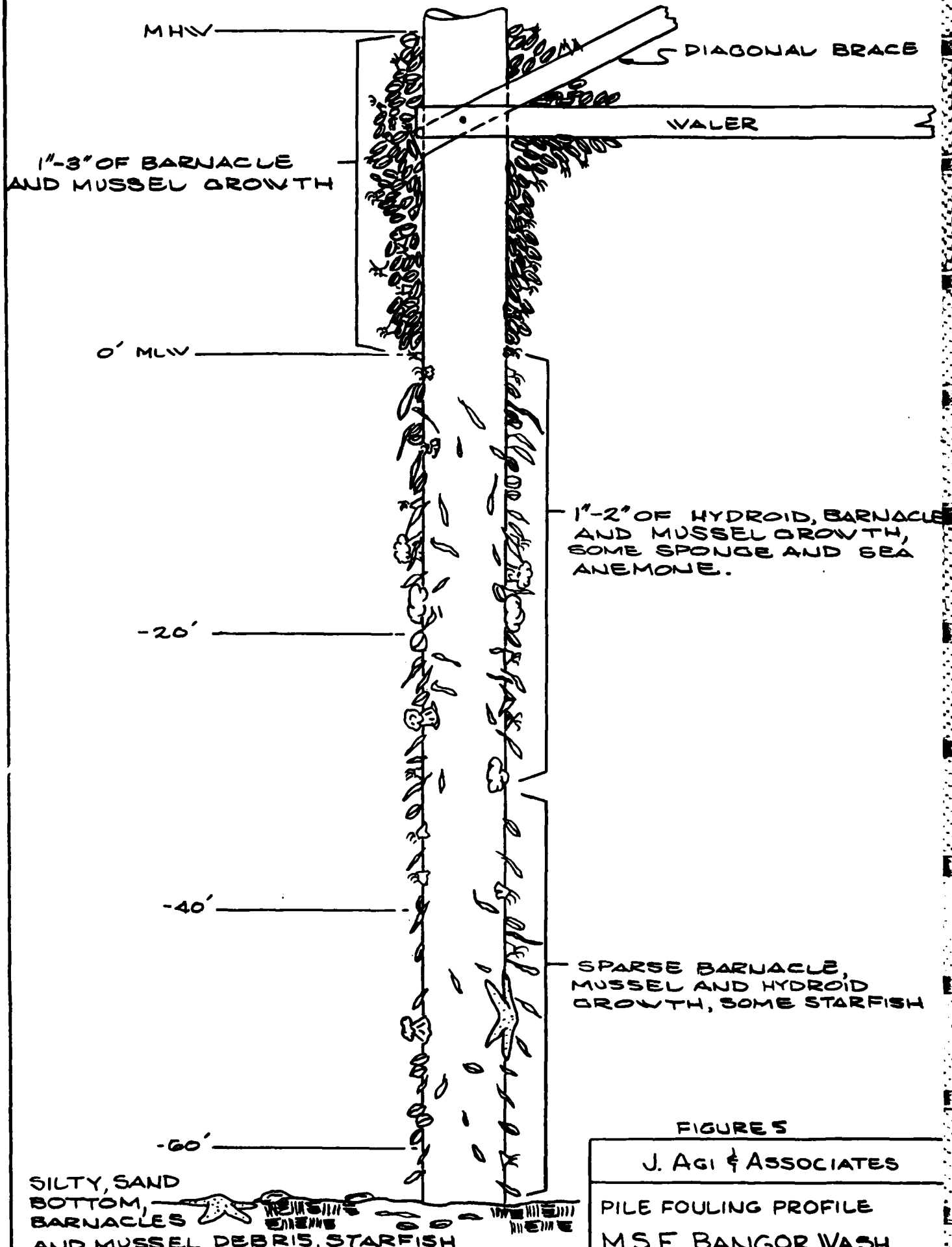
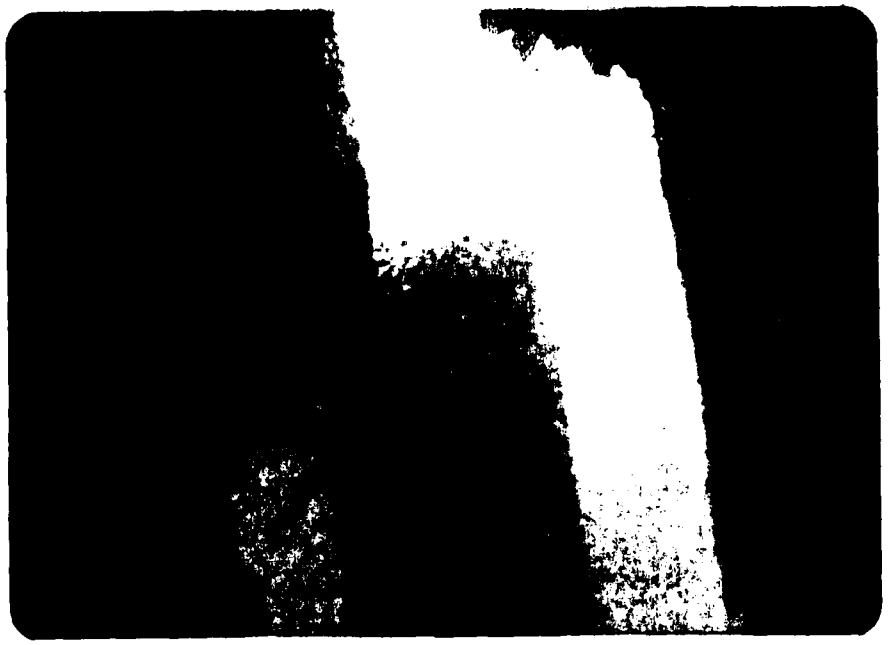


FIGURE 5

J. AGI & ASSOCIATES

PILE FOULING PROFILE

M.S.F. BANGOR WASH.



PHOTOGRAPH 13

Lower stub of broken pile 77W-3N. Note the misalignment of upper and lower pile sections.

PHOTOGRAPH 14

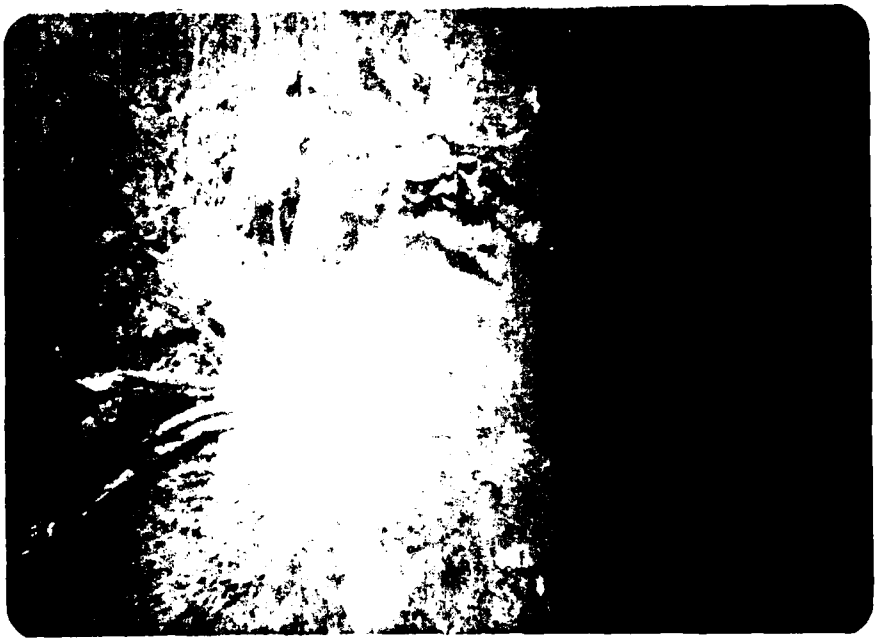
Top of lower stub of pile 77W-3N.

PHOTOGRAPH 15

Lower stub of pile 77W-3N. Note Bankia tunnels.

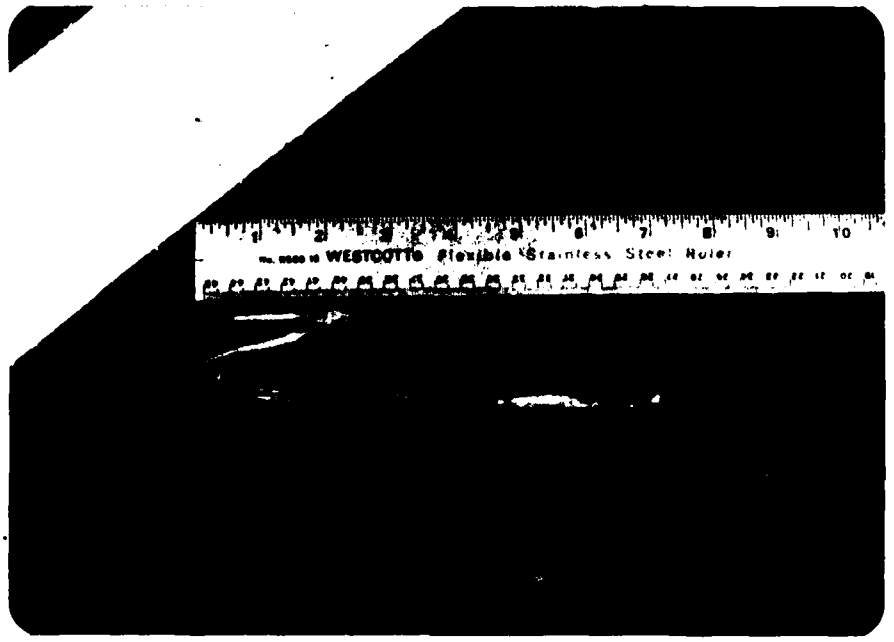
PHOTOGRAPH 16

Lower stub of pile 77W-3N. Note extensive Bankia infestation.



PHOTOGRAPH 17

Broken pile 77W-3S. Pile is broken and ruptured.



PHOTOGRAPH 18

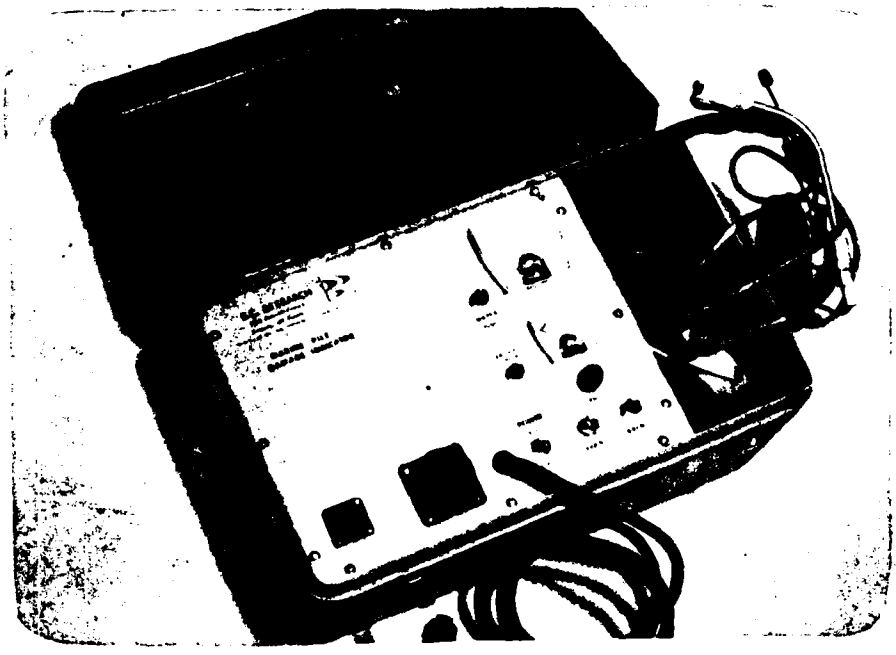
Live Bankia taken from damaged pile 77W-3N. Bankia measured 7 inches with a diameter of ½".

PHOTOGRAPH 19

Bankia infested pile section removed from pile 77W-3N. Live active Bankia seen in wood sample.

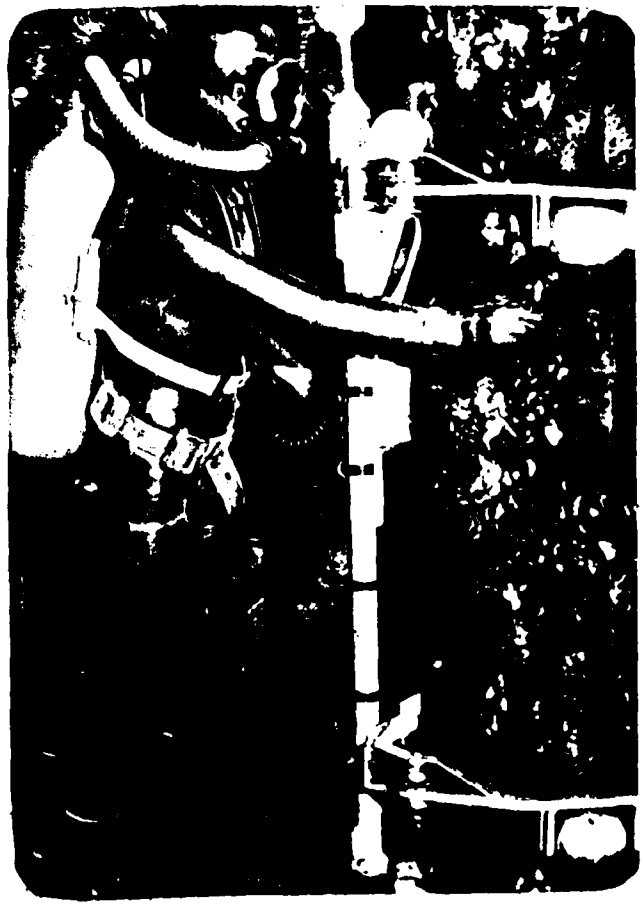
PHOTOGRAPH 20

Totally Bankia infested section of untreated timber located at the north end of the West Pier at -25 feet.



PHOTOGRAPH 21

The surface unit monitored by technician. The meter provides a continuous cross-sectional area readout -- also two-way telephone contact between diver and surface.



PHOTOGRAPH 22

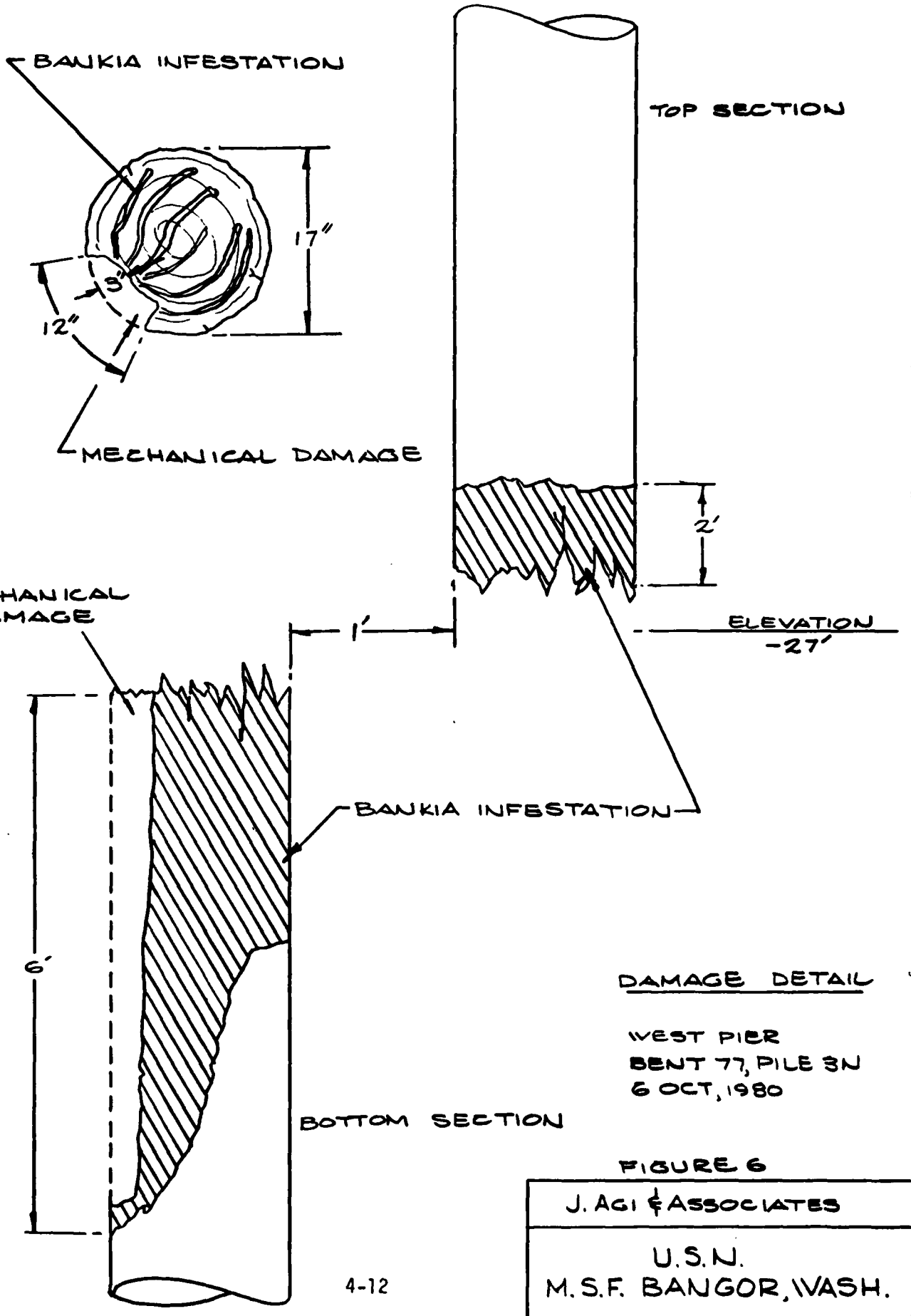
The ULTRASCAN - PTM4, the underwater sonic probe unit used to scan piles and locate internal damage. Probe is manipulated by diver.

PHOTOGRAPH 23

Cresosote treated pile section with virtually no evidence of internal damage -- shows the difficulty of providing quantitative structural data visual inspection.

PHOTOGRAPH 24

Same pile cut to show extensive internal teredine damage.



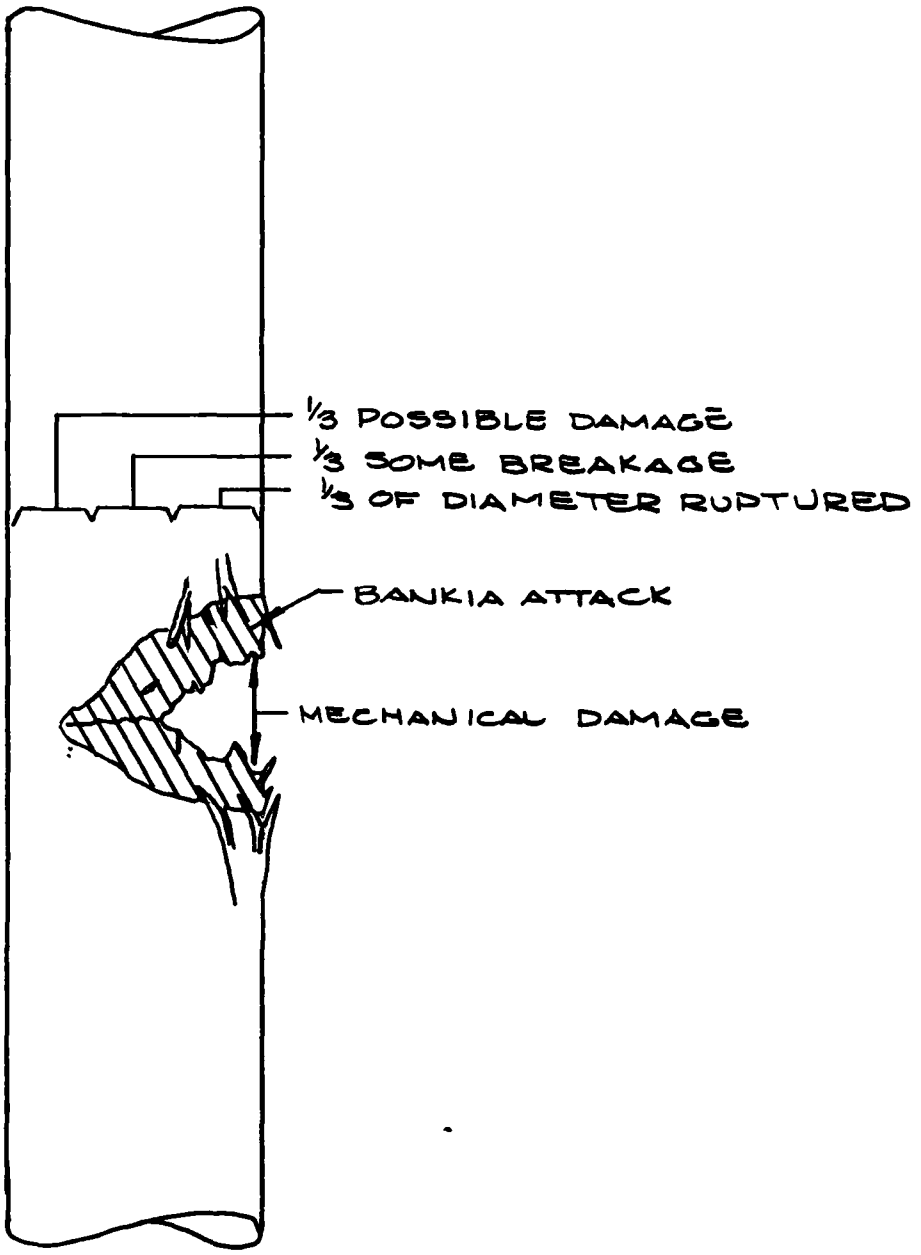
DAMAGE DETAIL

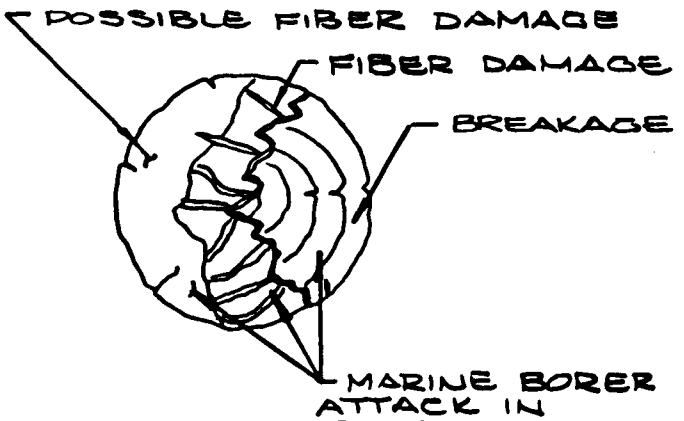
WEST PIER
BENT 77, PILE 3N
6 OCT, 1980

FIGURE 6

J. AGI & ASSOCIATES

U.S.N.
M.S.F. BANGOR, WASH.





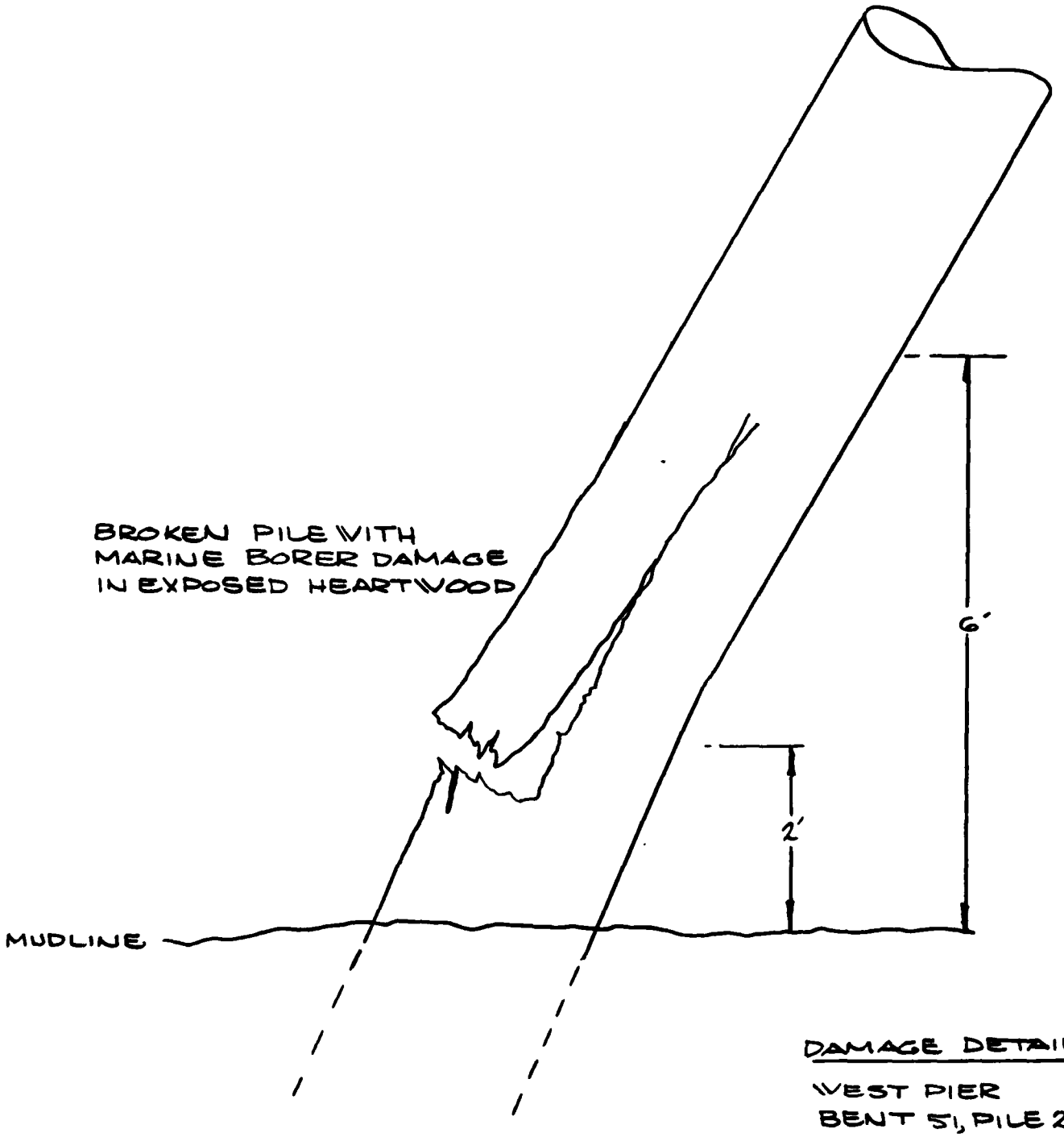
DAMAGE DETAIL

WEST PIER
BENT 77, PILE 35
6 OCT, 1980

FIGURE 7

J. AGI & ASSOCIATES

U.S.N.
M.S.F. BANGOR, WASH.



DAMAGE DETAIL

WEST PIER
BENT 51, PILE 2E

FIGURE 8

J. AGI & ASSOCIATES

U. S. N.
M.S.F. BANGOR, WASH.

The pile stubs have sustained heavy Bankia setacea attack and damage. Active live Bankia were found in the damaged pile stubs (see Photographs 15, 16 and 19). In some cases the borers had reached ½" in diameter and a length of 8-10". The 77W-3N pile, bottom stub, had sustained Bankia infestation down at least 6-7 feet from the break. The other pile stubs have also sustained borer attack through the exposed untreated areas of the piles.

Pile 51W-3E is broken at the mudline with marine borer (Bankia) attack at the area of rupture. This pile may have hit a rock below the mudline which resulted in "brooming" at the mudline during driving (see Figure 8).

An untreated cable support timber at Bent 77W had also sustained extensive Bankia damage (see Photograph 20).

Table 1, lists all the bents and piles examined and their residual cross-sectional area rating. Table 2, gives the total number and percentage of piles in each residual area group.

4.2 STRUCTURAL CONDITION ASSESSMENT

Based on the current partial pile inspection it was found that the piles and the facility are in excellent condition.

4.3 DISCUSSION

The overall condition of the examined marine piling was excellent. This situation is consistent with expectations for a properly treated and constructed facility of this age. Nevertheless, the facility is in an area of very heavy marine borer activity as shown by extensive monitoring data and substantiated by the Bankia attack found in piles 77W-3N and 77W-3S, 51W-2E and the untreated timbers. (Figures 6, 7 and 8).

This type of damage found in the three destroyed piling is typical of problems found in timber marine facilities. During the normal service

of a facility the piling are subject to mechanical impact, abrasion and the possible opening of cracks, splits and checks in the pile. As soon as the protective creosote layer, which is relatively narrow, is breached the pile becomes vulnerable to marine borer infestation.

The MSF pier will be subject to potential mechanical impact while fulfilling its normal function. Because of this and as indicated by the damage noted, the scenario of mechanical damage - marine borer infestation - destruction of the pile, will be an ongoing threat at this facility.

In general wood piling in the marine environment are subject to attack and damage by various species of marine borers. In the Pacific Northwest, loss of pile bearing strength occurs almost entirely from attack by Bankia setacea and Limnoria lignorum. In southern waters, teredine borers such as Teredo navalis and crustacean borers such as Limnoria tripunctata are of economic importance.

Both Bankia and Teredo are members of the family of internal marine borers Teredinideae. These animals begin their life cycle as free swimming larvae. When a suitable wood surface is found, they attach themselves and begin boring into the wood. At this point they also undergo a metamorphosis or body change to the adult, 'ship worm' form. As the animal bores into the wood it increases in size up to one-half inch or more in diameter and several feet in length. With this loss of wood volume, only a light infestation of borers will completely destroy a pile. When alive and actively boring the only visible signs of the animal are the two slender posterior siphons which extend beyond the wood. When the animal dies the only external sign of damage is the original 'pinhole' sized point of entry.

Limnoria attacks and damages wood at its surface. These animals begin boring as soon as they are hatched; they tunnel to a depth of approximately one-quarter inch and then bore along below the surface. Auxilliary tunnels are bored as the main tunnels are increased in length in order to provide access to water for respiration. The end result of many of these animals tunnelling on a pile is a seriously weakened

'honeycomb' like surface which is then abraded by wave action. As the older surfaces are eroded, new wood is exposed to attack. Whereas Teredines can destroy an unprotected pile in as little as nine months, the destructive action of Limnoria requires much more time.

Commercial protection for marine piles normally involves full cell pressure impregnation of creosote or a combination of creosote and water-borne toxic salts. Bankia larvae do not settle on well creosoted timbers, however, a mature Bankia can penetrate the creosote layer of a pile via a firmly attached untreated piece of wood. Limnoria lignorum is generally restricted by creosoting; whereas a second limnorial species, Limnoria tripunctata, is creosote-resistant. Although this species has been found at scattered locations in the northwest Pacific Coast, no documented cases of extensive economic damage have, as yet, been encountered in this area. In southern waters, however, Limnoria tripunctata has been of considerably more concern. Apart from its own destructive activity, Limnoria tripunctata can expose the untreated areas of a pile to Bankia attack by destroying the protective creosoted layer.

During the lifetime of creosoted piling in the marine environment, creosote will gradually leach out of the treated sapwood. As this process continues, the underlying heartwood becomes increasing vulnerable to marine borer attack. The time period between the driving of piling and the stage where general deterioration begins, will depend upon several factors. The most important of these factors includes the quality of the creosote treatment, the amount of pollution present in the environment, the presence or absence of floating logs and debris which may cause physical damage to the protective creosote layer through abrasion and breakage, as well as the growth on the piling of algae, barnacles, sea anemones and other marine life. The latter will, to the extent it is present, hamper the settlement of marine borer larvae on a pile and, therefore, constitute an additional barrier to infestation.

During the driving of treated piling, some accidental damage to a small percentage of these piles commonly occurs. Splitting or abrasion may provide entry points for marine borers, which subsequently may lead to

the complete destruction of the pile within one or two years. Since physical damage sustained during the driving of a pile often occurs at the mudline, underwater inspection is necessary for positive identification of all piling subjected to this type of damage. (Note pile 51W-2E.)

After the initial period of one or two years, the remaining sound piles may last several years before a widespread marine borer attack becomes noticeable.

At this stage, Limnoria commonly appear on piling surfaces, eroding away the sapwood wherever the creosote has disappeared to a sufficient degree. Two types of attack are common: the "general attack" and the "cavity". The general attack occurs only superficially and is characterized by a more extensive Limnoria activity concentrated at a limited area and extending in depth rather than width, reaching inwards to deeper layers of the wood. Limnoria cavities may occur where physical abrasion has reduced the thickness of the creosoted sapwood, or where cuts or open boltholes have not been closed by adequate repairs. However, even where no physical damage is present, Limnoria activity does sometimes occur and is probably a result of an initially uneven creosote retention, or attack by Limnoria tripunctata.

With the increasing age of a pile, the probability of teredine attack also increases. Teredo as well as Limnoria may gain entry through physically damaged areas on a pile. In undamaged piles, premature ingress of a Teredo may take place through knots, where the initial creosote retention is normally low. If, however, the borer dies before penetrating through the knots into the heartwood, which is sometimes the case, or where the absence of knots excludes their use as points of entry, an otherwise undamaged pile should resist teredine attacks until the process of creosote leaching has progressed to an advanced stage.

In view of the above observations, some general predictions about the service life of a marine structure may be made. Care should be taken, however, not to overestimate the reliability of prediction, since environmental fluctuations may drastically affect the projected service

life of piling. Also, and even where the environment is quite stable, individual differences between piling and the rates with which they succumb to creosote leaching make such predictions difficult. Therefore, it is generally a valid procedure to schedule sonic and visual inspections of marine piling at approximately 5-year intervals. When the stage is reached where wide-spread marine borer attack has set in, the inspection interval should be shortened to less than five years.

4.4 RECOMMENDATIONS

Since the facility is in an area of heavy marine borer activity, periodic visual inspections and sonic testing should be scheduled. The visual inspections may be scheduled annually or at least in a two year cycle. The sonic testing can be scheduled at five year intervals or more frequent if the visual surveys indicate areas of potential concern. Any subsequent inspections should include piling previously tested and also untested piles. This inspection procedure would monitor the possible deterioration of the facility and locate any areas of potential concern. Scheduling of inspections should be part of any overall maintenance plan for the facility. The enclosed maintenance planning critical path (Figure 9) is illustrative of the type of process recommended.

In conjunction with this pile inspection two related recommendations are made.

Because of the heavy marine borer activity in the area of the facility, it is strongly recommended that only properly treated wood be used, consistent with A.W.P.A. and U.S. Navy specifications, for any members exposed to water.

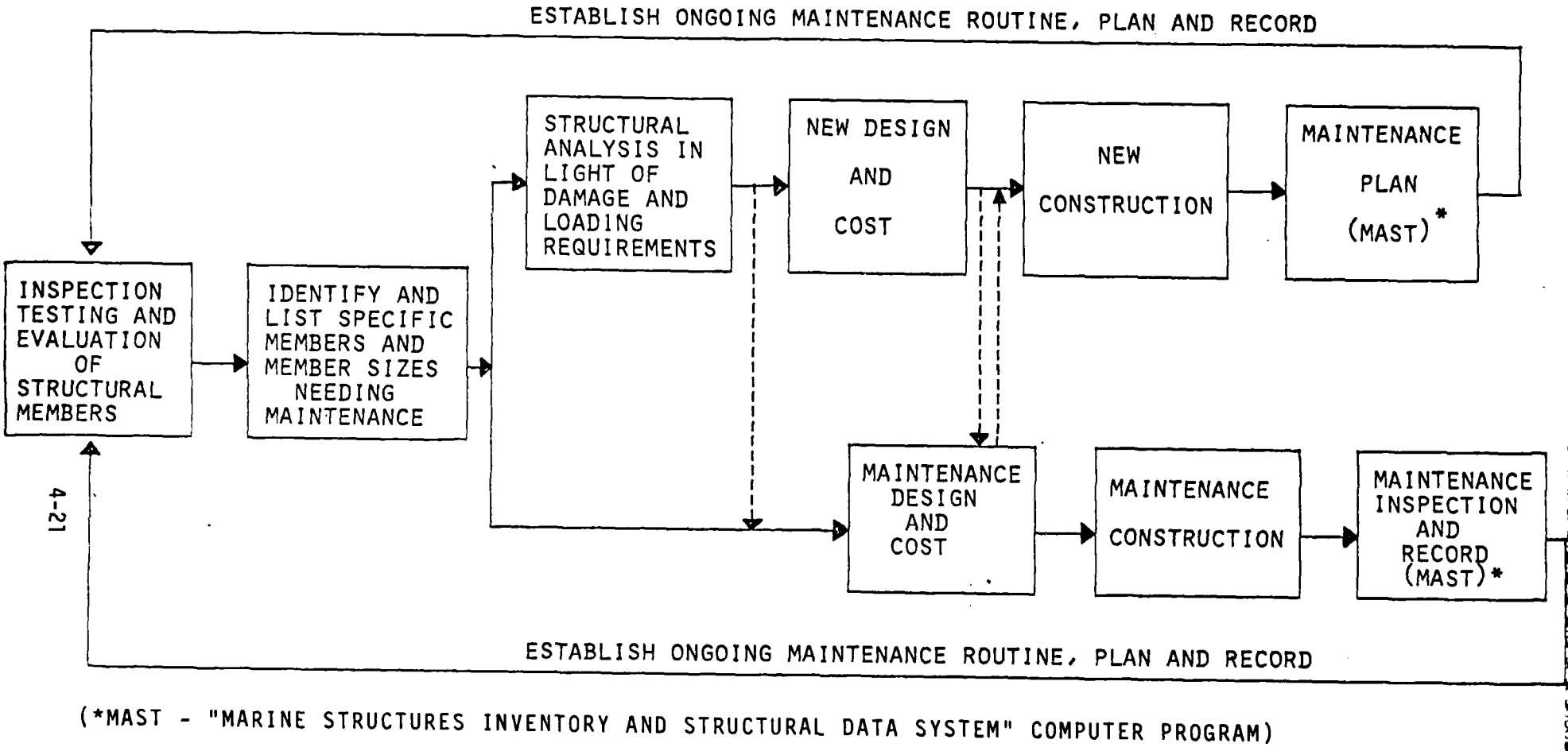
The mechanical damage sustained by piles 77W-3N and 77W-3S emphasized the need for an extensive protective fendering system at the outside ends of the East and West Piers. Planning for this may already have

been initiated by the Navy, if not, it is strongly recommended that this be done.

Pile 51W-2E may require replacement/repair if it is deemed essential for structural integrity of Bent 51W. At the writing of this report the repairs for piles 77W-3N and 77W-3S have been designed and are being implemented.

Removal of the damaged pile is recommended if driving of a replacement pile is anticipated. Removal of derelict piles facilitates the placing of replacement piles, facilitates future inspections and removes an immediate source of marine-borer infestation.

MAINTENANCE PLANNING - MARINE FACILITIES



(*MAST - "MARINE STRUCTURES INVENTORY AND STRUCTURAL DATA SYSTEM" COMPUTER PROGRAM)

FIGURE 9

SECTION 5 - CONCLUSIONS

The examined structure was found to be in excellent condition. The current partial inspection of 407 piling has, with considerable certainty, established the "base line" condition of the facility. This information can now form the basis for an ongoing study, augmented by subsequent inspections, which will monitor the condition of this strucuture throughout its service life. The information obtained will, of course, be pertinent to the structure in question, but even more, it will provide information on service life and deterioration patterns which can be applied to both design and maintenance at other facilities.

The accompanying critical path (page 4-21) shows a typical marine facilities maintenance planning procedure for both new and old structures.

LEGEND TO TABLES

B.	=	*Bankia setacea*
BR	=	Battered pile
c	=	Cavity resulting in loss of cross-section
conc.	=	Concrete encased pile
D	=	Damaged fender pile
E	=	East
h	=	Heavy attack
i	=	Incipient attack
ITZ	=	Intertidal zone
L.	=	*Limnoria*
LA	=	Limited access to sonic inspection
l	=	Light attack
m	=	Moderate attack
MBC	=	Marine-borer cavity
MB	=	Marine-borer
mdl	=	Mudline
m.l.w.	=	Mean low water
N	=	North
NB	=	Not bearing
n.a.	=	Pile not accessible for sonic inspection
n.i.	=	Pile missed by sonic inspection
NP	=	New replacement pile
n.t.	=	Pile not tagged
S	=	South
s	=	Severe attack
s	=	Pile has been stubbed
VO	=	Visual inspection only
W	=	West
un	=	Undamaged

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT PILE	l ft.	d in.	AREA RATING	REMARKS
APPROACHWAY:				
1 - 1	34	11*	100	Excellent condition
2E	34	11	100	Excellent condition
2W	34	11	100	Excellent condition
3	34	11	100	Excellent condition
2 - 1N	34	11	100	Excellent condition
1S	34	11	100	Excellent condition
2E	34	11	100	Excellent condition
2W	34	11	100	Excellent condition
3N	34	11	100	Excellent condition
3S	34	11	100	Excellent condition
3 - 1	36	11	100	Excellent condition
2E	36	11	100	Excellent condition
2W	36	11	100	Excellent condition
3	36	11	100	Excellent condition
4 - 1	37	11	100	Excellent condition
2E	37	11	100	Excellent condition
2W	37	11	100	Excellent condition
3	37	10	100	Excellent condition
7 - 1N	39	11	100	Excellent condition
1S	39	12	100	Excellent condition
2E	39	12	100	Excellent condition
2W	39	11	100	Excellent condition
3N	39	11	100	Excellent condition
3S	39	12	100	Excellent condition
8 - 1	39	12	100	Excellent condition
2E	39	11	100	Excellent condition
2W	39	12	100	Excellent condition
3	39	12	100	Excellent condition
11 - 1	39	13	100	Excellent condition
2E	39	12	100	Excellent condition
2W	39	12	100	Excellent condition
3	39	12	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

*Taken at 6' above mdl.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
12 -	1N	39	12	100	Excellent condition
	1S	39	12	100	Excellent condition
	2E	39	12	100	Excellent condition
	2W	39	12	100	Excellent condition
	3N	39	13	100	Excellent condition
	3S	39	13	100	Excellent condition
15 -	1	37	12*	100	Excellent condition
	2E	37	12	100	Excellent condition
	2W	37	12	100	Excellent condition
	3	37	13	100	Excellent condition
16 -	1	36	13	100	Excellent condition
	2E	36	12	100	Excellent condition
	2N	36	13	100	Excellent condition
	3	36	12	100	Kelp fouling attached to piles.
19 -	1	45	17**	100	Excellent condition
	2E	45	16	100	Excellent condition
	2W	45	13	100	Excellent condition
	3	45	15	100	Excellent condition
20 -	1	46	16	100	Excellent condition
	2E	46	15	100	Small shake (1") off in ITZ.
	2W	46	15	100	Excellent condition
	3	46	15	100	Excellent condition
23 -	1	52	15	100	Excellent condition
	2E	52	16	100	Excellent condition
	2W	52	16	100	Excellent condition
	3	52	16	100	Excellent condition
24 -	1	53	16	100	Excellent condition
	2E	53	18	100	Excellent condition
	2W	53	16	100	Excellent condition
	3	53	16	100	Excellent condition
27 -	1N	56	16	100	Excellent condition
	1S	56	18	100	Excellent condition
	2E	56	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

*Taken at 15' above mdl. **Taken at 30' above mdl.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
27 -	2W	56	18	100	Excellent condition
	3N	56	18	100	Excellent condition
	3S	56	18	100	Excellent condition
28 -	1	58	16	100	-10' check
	2N	58	16	100	Excellent condition
	2S	58	16	100	Excellent condition
	3	58	18	100	Excellent condition
HEADER PIER:					
30 -	1	59	17*	100	Fouling covers all area of pile, 1".
	2N	59	17	100	Excellent condition
	2S	59	17	100	Excellent condition
	3	59	17	100	Excellent condition
33 -	1E	66	18	100	Excellent condition
	1W	66	18	100	Excellent condition
	2N	66	17	100	Excellent condition
	2S	66	17	100	Excellent condition
	3E	66	17	100	Excellent condition
	3W	66	17	100	Excellent condition
34 -	1	66	15	100	Excellent condition
	2N	66	18	100	Excellent condition
	2S	66	16	100	Excellent condition
	3	66	15	100	Excellent condition
35 -	1E	66	15	100	Rows 1 and 2, bent 34-35, walers support cables at -45', mdl +15'.
	1W	66	17	100	Heavier fouling.
	2N	66	16	100	Excellent condition
	2S	66	16	100	Tube worms, spotty, 1' long.
	3E	66		100	Fouling heavier on north side.
	3W	66		100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

*Taken 3' below cap.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT PILE	l* ft.	d in.	AREA RATING	REMARKS
WEST PIER:				
37W - 1	72*	17	100	Excellent condition
2W	72	19	100	¼" wide check at mdl
2E	72	17	100	Excellent condition
3	71	17	100	Excellent condition
38W - 1	73	17	100	Excellent condition
2W	73	19	100	Excellent condition
2E	73	17	100	Excellent condition
3	73	17	100	Excellent condition
40W - 1W	71	17	100	Excellent condition
1E	71	17	100	Excellent condition
2W	71	18	100	Excellent condition
2E	71	17	100	Excellent condition
3W	71	17	100	Excellent condition
3E	71	17	100	Excellent condition
42W - 1	71	17	100	Excellent condition
1N	71	18	100	Excellent condition
1S	71	18	100	Excellent condition
2W	71	17	100	Excellent condition
2E	71	18	100	Excellent condition
3	71	17	100	Excellent condition
3N	71	17	100	Excellent condition
3S	71	17	100	Excellent condition
43W - 1E	71	16	100	Excellent condition
1W	71	17	100	Excellent condition
2E	71	18	100	Excellent condition
2W	71	16	100	Excellent condition
3E	71	17	100	Excellent condition
3W	17	19	100	Excellent condition
46W - 1	76	17	100	Excellent condition
1N	76	17	100	Excellent condition
1S	76	17	100	Excellent condition
2E	75	18	100	Excellent condition
2W	75	16	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

*mdl-cap pile length, reduce by 12' to account for timber bracing & framing at top.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT PILE	l ft.	d in.	AREA RATING	REMARKS
46W - 3	73	18	100	Excellent condition
3N	73	18	100	Excellent condition
3S	73	18	100	Excellent condition
47W - 1E	76	18	100	Excellent condition
1W	76	17	100	Excellent condition
2E	75	17	100	Excellent condition
2W	75	18	100	Excellent condition
3E	74	18	100	Excellent condition
3W	74	18	100	Excellent condition
50W - 1	79	18	100	Excellent condition
1N	79	17	100	Excellent condition
1S	79	17	100	Excellent condition
2E	77	17	100	Excellent condition
2W	77	18	100	Excellent condition
3	77	17	100	Excellent condition
3N	75	17	100	Excellent condition
3S	75	17	100	Excellent condition
51W - 1E	80	17	100	Excellent condition
1W	80	19	100	Excellent condition
2E	77	17	0	Broken at mdl, 90% section loss, B.
2W	77	19	100	Excellent condition
3E	75	17	100	Excellent condition
3W	75	17	100	Excellent condition
54W 1E	80	18	100	Excellent condition
1W	80	18	100	Excellent condition
1N	80	18	100	Excellent condition
1S	80	18	100	Excellent condition
2E	76	17	100	Excellent condition
2W	76	17	100	Excellent condition
3E	74	18	100	Excellent condition
3W	74	18	100	Excellent condition
3N	74	18	100	Excellent condition
3S	74	17	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
55W -	1E	80	18	100	Excellent condition
	1W	80	18	100	Excellent condition
	2E	77	18	100	Excellent condition
	2W	77	18	100	Excellent condition
	3E	75	19	100	Excellent condition
	3W	75	17	100	Excellent condition
58W -	1	80	19	100	Excellent condition
	1N	80	19	100	Excellent condition
	1S	78	18	100	Excellent condition
	2E	78	17	100	Excellent condition
	2W	78	18	100	Excellent condition
	3	73	18	100	Excellent condition
	3N	75	19	100	Excellent condition
	3S	75	18	100	Excellent condition
59W -	1E	79	17	100	Excellent condition
	1W	79	18	100	Excellent condition
	2E	77	18	100	Excellent condition
	2W	77	18	100	Excellent condition
	3E	76	17	100	Excellent condition
	3W	76	16	100	Excellent condition
62W -	1	78	18	100	Excellent condition
	1N	78	17	100	Excellent condition
	1S	78	17	100	Excellent condition
	2E	77	17	100	Excellent condition
	2W	77	17	100	Excellent condition
	3	76	18	100	Excellent condition
	3N	76	18	100	Excellent condition
	3S	76	17	100	Excellent condition
63W -	1E	78	17	100	Excellent condition
	1W	77	18	100	Excellent condition
	2E	75	18	100	Excellent condition
	2W	75	18	100	Excellent condition
	3E	74	16	100	Excellent condition
	3W	74	17	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT PILE	l ft.	d in.	AREA RATING	REMARKS
66W - 1	73	18	100	Excellent condition
1N	73	17	100	Excellent condition
1S	73	17	100	Excellent condition
2E	72	19	100	Excellent condition
2W	72	21	100	Excellent condition
3	71	18	100	Excellent condition
3N	71	18	100	Excellent condition
3S	71	16	100	Excellent condition
67W - 1E	73	19	100	Excellent condition
1W	73	17	100	Excellent condition
2E	72	18	100	Excellent condition
2W	72	17	100	Excellent condition
3	71	19	100	Excellent condition
3N	71	18	100	Excellent condition
3S	71	19	100	Excellent condition
70W - 1	74	18	100	Excellent condition
1N	74	18	100	Excellent condition
1S	73	18	100	Excellent condition
2E	72	18	100	Excellent condition
2N	72	19	100	Excellent condition
2W	72	18	100	Excellent condition
3	71	18	100	Excellent condition
3N	71	19	100	Excellent condition
3S	71	16	100	Excellent condition
71W - 1E	74	17	100	Excellent condition
1W	74	17	100	Excellent condition
2E	73	17	100	Excellent condition
2W	73	17	100	Excellent condition
3	71	18	100	Excellent condition
3N	71	18	100	Excellent condition
3S	71	18	100	Excellent condition
72W - 1E	74	17	100	Excellent condition
1E	74	17	100	Excellent condition
2E	73	18	100	Excellent condition
2W	73	17	100	Excellent condition
3	72	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
72W -	3N	72	17	100	Excellent condition
	3S	72	19	100	Excellent condition
73W -	1E	74	17	100	Excellent condition
	1W	74	17	100	Excellent condition
	2E	73	18	100	Excellent condition
	2E	73	17	100	Excellent condition
	3	72	18	100	Excellent condition
	3N	72	18	100	Excellent condition
	3S	72	18	100	Excellent condition
74W -	1E	74	18	100	Excellent condition
	1W	74	18	100	Excellent condition
	2E	73	18	100	Excellent condition
	2W	73	18	100	Excellent condition
	3	72	18	100	Excellent condition
	3N	72	18	100	Excellent condition
	3S	72	18	100	Excellent condition
75W -	1E	74	17	100	Excellent condition
	1W	74	17	100	Excellent condition
	2E	73	17	100	Excellent condition
	2W	73	17	100	Excellent condition
	3	72	18	100	Excellent condition
	3N	72	18	100	Excellent condition
	3S	72	17	100	Excellent condition
76W -	1E	75	17	100	Excellent condition
	1W	75	17	100	Excellent condition
	2E	74	18	100	Excellent condition
	2W	74	18	100	Excellent condition
	3	73	19	100	Excellent condition
	3N	73	19	100	Excellent condition
	3S	73	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
77W -	1E	76	18	100	Excellent condition
	1W	76	17	100	Excellent condition
	2E	75	18	100	Excellent condition
	2W	75	18	100	Excellent condition
	3	74	19	100	Excellent condition
	3N	74	17	0	Sheared off at -8' to 10' below 0'.
	3S	74	18	0	Broken and cracked -8' to 10' below 0'.
EAST PIER:					
42E -	1N	63	16	100	Excellent condition
	1S	63	18	100	Excellent condition
	2E	67	17	100	Excellent condition
	2W	63	16	100	Excellent condition
	3N	63	16	100	Excellent condition
	3S	63	16	100	Excellent condition
43E -	1	63	16	100	Excellent condition
	2E	63	17	100	Excellent condition
	2W	63	17	100	Excellent condition
	3	63	15	100	Excellent condition
46E -	1N	63	16	100	Excellent condition
	1S	63	15	100	Excellent condition
	2E	63	16	100	Excellent condition
	2W	63	16	100	Excellent condition
	3N	63	16	100	Excellent condition
	3S	63	15	100	Excellent condition
47E -	1	63	16	100	Excellent condition
	2E	63	17	100	Excellent condition
	2W	63	20	100	Excellent condition
	3	63	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
50E	1N	65	17	100	Excellent condition
	1S	65	17	100	Excellent condition
	2E	65	17	100	Excellent condition
	2W	65	17	100	Excellent condition
	3N	65	16	100	Excellent condition
	3S	65	18	100	Excellent condition
51E	1	65	19	100	Excellent condition
	2E	65	19	100	Excellent condition
	2W	65	17	100	Excellent condition
	3	66	17	100	Excellent condition
54E	1N	66	17	100	Excellent condition
	1S	66	16	100	¼" wide check, 2' long at -10'.
	2E	66	15	100	Excellent condition
	2W	66	16	100	Excellent condition
	3N	66	17	100	Excellent condition
	3S	66	19	100	Excellent condition
55E	1	66	17	100	Excellent condition
	2E	66	16	100	Excellent condition
	2W	66	17	100	Excellent condition
	3	66	17	100	Excellent condition
58E	1	67	17	100	Excellent condition
	1N	67	17	100	Excellent condition
	1S	67	17	100	Excellent condition
	2E	67	17	100	Excellent condition
	2W	67	16	100	Excellent condition
	3	67	17	100	Excellent condition
	3N	67	17	100	Excellent condition
	3S	67	18	100	Excellent condition
59E	1E	67	18	100	Excellent condition
	1W	67	15	100	Excellent condition
	2E	67	17	100	Excellent condition
	2W	67	17	100	Excellent condition
	3E	67	16	100	Excellent condition
	3W	67	19	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
62E -	ON	63	16	100	Excellent condition
	OS	63	15	100	Excellent condition
62 -	1	63	16	100	Excellent condition
	1N	63	17	100	Excellent condition
	1S	63	16	100	Excellent condition
	2E	63	17	100	Excellent condition
	2W	63	16	100	Excellent condition
	3	63	16	100	Excellent condition
	3N	63	16	100	Excellent condition
	3S	63	17	100	Excellent condition
63E -	1E	63	17	100	Excellent condition
	1W	63	16	100	Excellent condition
	2E	63	16	100	Shakes off pile surface.
	2W	63	16	100	Excellent condition
	3E	63	18	100	Excellent condition
	3W	63	18	100	Excellent condition
66E -	1	60	16	100	Excellent condition
	1N	60	17	100	Excellent condition
	1S	60	17	100	Excellent condition
	2E	60	17	100	Excellent condition
	2W	60	18	100	Excellent condition
	3	60	18	100	Excellent condition
	3N	60	17	100	Excellent condition
	3S	60	19	100	Excellent condition
67E -	1E	60	15	100	Excellent condition
	1W	60	16	100	Excellent condition
	2E	60	16	100	Excellent condition
	2W	60	16	100	Excellent condition
	3	60	19	100	Excellent condition
	3N	60	18	100	Excellent condition
	3S	60	19	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
70E -	1	62	15	100	Excellent condition
	1N	62	15	100	Excellent condition
	1S	62	16	100	Excellent condition
	2E	62	17	100	Excellent condition
	2W	62	16	100	Excellent condition
	3	62	16	100	Excellent condition
	3N	62	17	100	Excellent condition
	3S	62	17	100	Excellent condition
71E -	1E	62	17	100	Excellent condition
	1W	62	17	100	Excellent condition
	2E	62	16	100	Excellent condition
	2W	62	20	100	Excellent condition
	3	62	17	100	Excellent condition
	3N	62	16	100	Excellent condition
	3S	62	17	100	Excellent condition
72E -	1E	63	17	100	Excellent condition
	1W	63	17	100	Excellent condition
	2E	63	17	100	Excellent condition
	2W	63	17	100	Excellent condition
	3	63	17	100	Excellent condition
	3W	63	17	100	Excellent condition
	3S	63	17	100	Excellent condition
73E -	1E	63	18	100	Excellent condition
	1W	63	17	100	Excellent condition
	2E	63	16	100	Excellent condition
	2W	63	16	100	Excellent condition
	3	63	17	100	Excellent condition
	3N	63	16	100	Excellent condition
	3S	63	17	100	Excellent condition
74E -	1E	63	16	100	Excellent condition
	1W	63	16	100	Light mechanical shaking.
	2E	63	16	100	Excellent condition
	2W	63	16	100	Excellent condition
	3	63	16	100	Excellent condition
	3N	63	16	100	Excellent condition
	3S	63	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 1

REMAINING CROSS-SECTIONAL AREA AND DESCRIPTION OF DAMAGE TO INDIVIDUAL PILING

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

PILE ID BENT	PILE	l ft.	d in.	AREA RATING	REMARKS
75E -	1E	63	18	100	Excellent condition
	1W	63	17	100	Excellent condition
	2E	63	17	100	Excellent condition
	2W	63	20	100	Excellent condition
	3	63	19	100	Excellent condition
	3N	63	17	100	Excellent condition
	3S	63	17	100	Excellent condition
76E -	1E	64	16	100	Excellent condition
	1W	64	17	100	Excellent condition
	2E	64	17	100	Excellent condition
	2W	64	16	100	Excellent condition
	3	64	19	100	Excellent condition
	3N	64	17	100	Excellent condition
	3S	64	17	100	Excellent condition
77E -	1E	64	16	100	Excellent condition
	1W	64	18	100	Excellent condition
	2E	64	17	100	Excellent condition
	2W	64	17	100	LA - electric cables.
	3	64	17	100	Excellent condition
	3S	64	18	100	Excellent condition

l = mdl-cap pile length; d = average original pile diameter.

TABLE 2

NUMBER AND PERCENTAGE OF PILING IN EACH CROSS-SECTIONAL AREA CLASSIFICATION

MAGNETIC SILENCING FACILITY, BANGOR, WASHINGTON

Percent Remaining Cross-Sectional Area	Number	Percent
100	404	99.5
90	0	0
75	0	0
50	0	0
25	0	0
0	3	0.5
TOTAL:	407	100

TABLE 3

COLUMN LOAD CAPACITY CALCULATIONS

Pile load capacities were calculated by an inhouse computer program using the Southern Pine Association modified Euler equation for long columns where,

$$P_{ult} = \frac{0.30\ E}{(L/d)^2} \times A$$

Pile lengths (L) were taken from mudline to cap. The unsupported length of pile (USL) was taken from below the bracing at the top and ten feet was added at the mudline to allow for the point of fixity. Effective length factor (K) of 0.8 was used. Other program parameters used are described below:

Bent - bent identification

PIle - pile (row) identification

ITP - type of wood (1=fir)

Length - unsupported length - in this project, 10 feet was added onto the USL since the point of fixity at the bottom was considered to be 10 feet below the mudline.

EFF-L Factor - effective length factor, K. K=0.8 was used for these calculations

ORG-DIA - original pile diameter - taken at mudline

EFF-ARA - remaining cross-sectional area based on sonic testing, on the following basis:

Factor	Cross-Sectional area remaining
1.00	100%
0.90	90%-100%
0.75	75%-100%
0.50	50%- 75%
0.25	25%- 50%
0.005*	0%- 25%

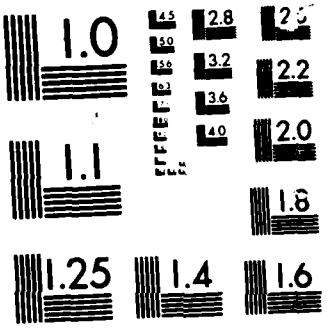
(*the program cannot handle 0.000)

EFF-DIA - effective pile diameter

EFF-ARA - effective cross-sectional area of pile

AD-A165 938 UNDERWATER FACILITIES INSPECTION AND ASSESSMENT AT MAGNETIC SILENCING FAC.. (U) AGI (J) AND ASSOCIATES INC SEATTLE WA OCT 80 CHES/NAVFAC-FPO-1-80(13) 2/2

UNCLASSIFIED N62477-80-C-0265 F/G 13/10.1 NL



MICROCOPY RESOLUTION TEST CHART

C	-	compression parallel to grain, in psi, for fir
L/D	-	length over diameter ratio
P-ULT, LB	-	ultimate loading capacity of the pile column in pounds. This refers only to the column length as shown and does not take into account soil conditions (other than to establish the point of fixity), and what the pile was originally driven to in terms of design loads.

It is strongly emphazied that these calculations deal only with the ultimate capacity of the wood pile column within the fixity conditions and USL parameters as perceived. These load calculations are not design load calculations.

(Structural analysis in light of lateral loading was not included since this is considerably beyond the scope of this project. Such an analysis would require details on imposed lateral loading and structural analysis of the entire facility in terms of these loads and existing structural parameters.)

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
BANGOR WASHINGTON NOVEMBER 18, 1980
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
APPROACHWAY PILING											
1	1	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	2E	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	2W	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	3	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
2	1N	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	1S	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	2E	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	2W	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	3N	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
	3S	1	34.00	0.800	0.920	1.000	0.920	95.73	549.	30	52566.
3	1	1	36.00	0.800	0.920	1.000	0.920	95.73	490.	31	46888.
	2E	1	36.00	0.800	0.920	1.000	0.920	95.73	490.	31	46888.
	2W	1	36.00	0.800	0.920	1.000	0.920	95.73	490.	31	46888.
	3	1	36.00	0.800	0.920	1.000	0.920	95.73	490.	31	46888.
4	1	1	37.00	0.800	0.920	1.000	0.920	95.73	464.	32	44388.
	2E	1	37.00	0.800	0.920	1.000	0.920	95.73	464.	32	44388.
	2W	1	37.00	0.800	0.920	1.000	0.920	95.73	464.	32	44388.
	3	1	37.00	0.800	0.830	1.000	0.830	77.91	377.	36	29485.
7	1N	1	39.00	0.800	0.920	1.000	0.920	95.73	417.	34	39951.
	1S	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2E	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2W	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	3N	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	3S	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
8	1	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2E	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2W	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	3	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
11	1	1	39.00	0.800	1.000	1.000	1.000	131.92	575.	29	75872.
	2E	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2W	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	3	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
12	1N	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	1S	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2E	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	2W	1	39.00	0.800	1.000	1.000	1.000	113.10	493.	31	55768.
	3N	1	39.00	0.800	1.000	1.000	1.000	131.92	575.	29	75872.
	3S	1	39.00	0.800	1.000	1.000	1.000	131.92	575.	29	75872.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
BANGOR WASHINGTON NOVEMBER 18, 1980
-1

BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
15	1	1	37.00	0.800	1.000	1.000	1.000	113.10	548.	30	61960.
	2E	1	37.00	0.800	1.000	1.000	1.000	113.10	548.	30	61960.
	2W	1	37.00	0.800	1.000	1.000	1.000	113.10	548.	30	61960.
	3	1	37.00	0.802	1.000	1.000	1.000	131.92	639.	27	84296.
16	1	1	36.00	0.800	1.000	1.000	1.000	131.92	675.	27	89044.
	2E	1	36.00	0.800	1.000	1.000	1.000	113.10	579.	29	65450.
	2W	1	36.00	0.800	1.000	1.000	1.000	131.92	675.	27	89044.
	3	1	36.00	0.800	1.000	1.000	1.000	113.10	579.	29	65450.
19	1	1	45.00	0.800	1.420	1.000	1.420	228.05	705.	25	160775.
	2E	1	45.00	0.800	1.330	1.000	1.330	200.06	655.	27	131068.
	2W	1	45.00	0.800	1.000	1.000	1.000	131.92	432.	33	56988.
	3	1	45.00	0.800	1.250	1.000	1.250	176.71	579.	29	102265.
20	1	1	46.00	0.800	1.330	1.000	1.330	200.06	627.	28	125431.
	2E	1	46.00	0.800	1.250	1.000	1.250	176.71	554.	29	97867.
	2W	1	46.00	0.800	1.250	1.000	1.250	176.71	554.	29	97867.
	3	1	46.00	0.800	1.250	1.000	1.250	176.71	554.	29	97867.
23	1	1	52.00	0.800	1.250	1.000	1.250	176.71	433.	33	76586.
	2E	1	52.00	0.800	1.330	1.000	1.330	200.06	491.	31	98155.
	2W	1	52.00	0.800	1.330	1.000	1.330	200.06	491.	31	98155.
	3	1	52.00	0.800	1.330	1.000	1.330	200.06	491.	31	98155.
24	1	1	53.00	0.800	1.330	1.000	1.330	200.06	472.	32	94486.
	2E	1	53.00	0.800	1.500	1.000	1.500	254.47	601.	28	152372.
	2W	1	53.00	0.800	1.330	1.000	1.330	200.06	472.	32	94486.
	3	1	53.00	0.800	1.330	1.000	1.330	200.06	472.	32	94486.
27	1N	1	56.00	0.802	1.330	1.000	1.330	200.06	423.	34	84634.
	1S	1	56.00	0.800	1.500	1.000	1.500	254.47	538.	30	136931.
	2E	1	56.00	0.802	1.500	1.000	1.500	254.47	538.	30	136931.
	2W	1	56.00	0.800	1.500	1.000	1.500	254.47	538.	30	136931.
	3N	1	56.00	0.800	1.500	1.000	1.500	254.47	538.	30	136931.
	3S	1	56.00	0.800	1.500	1.000	1.500	254.47	538.	30	136931.
29	1	1	58.00	0.800	1.330	1.000	1.330	200.06	394.	35	78898.
	2N	1	58.00	0.800	1.330	1.000	1.330	200.06	394.	35	78898.
	2S	1	58.00	0.800	1.330	1.000	1.330	200.06	394.	35	78898.
	3	1	56.00	0.800	1.500	1.000	1.500	254.47	502.	31	127651.
HEADER PIER											
30	1	1	59.00	0.800	1.420	1.000	1.420	228.05	434.	33	99075.
	2N	1	59.00	0.800	1.420	1.000	1.420	228.05	434.	33	99075.
	2S	1	59.00	0.800	1.420	1.000	1.420	228.05	434.	33	99075.
	3	1	59.00	0.800	1.420	1.000	1.420	228.05	434.	33	99075.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
BANGOR WASHINGTON NOVEMBER 18, 1980
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
33	1E	1	66.00	0.800	1.500	1.000	1.500	254.47	387.	35	98580.
	1W	1	66.00	0.800	1.500	1.000	1.500	254.47	387.	35	98580.
	2N	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	2S	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	3E	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	3W	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
34	1	1	66.00	0.800	1.250	1.000	1.250	176.71	269.	42	47541.
	2N	1	66.00	0.800	1.500	1.000	1.500	254.47	387.	35	98580.
	2S	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	3	1	66.00	0.800	1.250	1.000	1.250	176.71	269.	42	47541.
35	1E	1	66.00	0.800	1.250	1.000	1.250	176.71	269.	42	47541.
	1W	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	2N	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	2S	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	3E	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	3W	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
WEST PIER											
37W	1	1	72.00	0.800	1.420	1.000	1.420	228.05	292.	41	66528.
	2W	1	72.00	0.800	1.580	1.000	1.580	282.34	361.	36	101971.
	2E	1	72.00	0.800	1.420	1.000	1.420	228.05	292.	41	66529.
	3	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
38W	1	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	2W	1	73.00	0.800	1.580	1.000	1.580	282.34	351.	37	99196.
	2E	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	3	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
40W	1W	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	1E	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	2W	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	2S	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	3W	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	3E	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
42W	1	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	1N	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	1S	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	2W	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	2E	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	3N	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	3S	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
43W	1E	1	71.00	0.800	1.330	1.000	1.330	200.06	263.	43	52651.
	1W	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	2E	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	2W	1	71.00	0.800	1.330	1.000	1.330	200.06	263.	43	52651.
	3E	1	71.00	0.800	1.420	1.000	1.420	228.05	300.	40	68415.
	3W	1	71.00	0.800	1.580	1.000	1.580	282.34	371.	36	104864.
46W	1	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	1N	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	1S	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	2E	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	2W	1	75.00	0.800	1.330	1.000	1.330	200.06	236.	45	47184.
	3	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	3N	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	3S	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
47W	1E	1	76.00	0.800	1.500	1.000	1.500	254.47	292.	41	74345.
	1W	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	2E	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
	2W	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	3E	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	3W	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
50W	1	1	79.00	0.800	1.500	1.000	1.500	254.47	270.	42	68806.
	1N	1	79.00	0.800	1.420	1.000	1.420	228.05	242.	45	55260.
	1S	1	79.00	0.800	1.420	1.000	1.420	228.05	242.	45	55260.
	2E	1	77.00	0.800	1.420	1.000	1.420	228.05	255.	43	58168.
	2W	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	3	1	77.00	0.800	1.420	1.000	1.420	228.05	255.	43	58168.
	3N	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
	3S	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
51W	1E	1	80.00	0.800	1.420	1.000	1.420	228.05	236.	45	53887.
	1W	1	80.00	0.800	1.580	1.000	1.580	282.34	293.	41	82596.
	2E	1	77.00	0.800	1.420	0.005	0.100	1.14	1.	613	1.
	2W	1	77.00	0.800	1.580	1.000	1.580	282.34	316.	39	89158.
	3E	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
	3W	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
54W	1N	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67896.
	1S	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67896.
	1E	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67896.
	1W	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67896.
	2E	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	2W	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	3W	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	3N	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	3S	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	3E	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
55W	1E	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67096.
	1W	1	80.00	0.800	1.500	1.000	1.500	254.47	264.	43	67096.
	2E	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	2W	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	3E	1	75.00	0.800	1.580	1.000	1.580	282.34	333.	38	93976.
	3W	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
58W	1	1	80.00	0.800	1.580	1.000	1.580	282.34	293.	41	82596.
	1N	1	80.00	0.800	1.580	1.000	1.580	282.34	293.	41	82596.
	1S	1	78.00	0.800	1.500	1.000	1.500	254.47	277.	42	70581.
	2E	1	76.00	0.800	1.420	1.000	1.420	228.05	249.	44	56686.
	2W	1	78.00	0.800	1.500	1.000	1.500	254.47	277.	42	70581.
	3	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	3N	1	75.00	0.800	1.580	1.000	1.580	282.34	333.	38	93976.
	3S	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
59W	1E	1	79.00	0.800	1.420	1.000	1.420	228.05	242.	45	55260.
	1W	1	79.00	0.800	1.500	1.000	1.500	254.47	270.	42	68806.
	2E	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	2W	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	3E	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	3W	1	76.00	0.800	1.330	1.000	1.330	200.06	230.	46	45951.
62W	1	1	78.00	0.800	1.500	1.000	1.500	254.47	277.	42	70581.
	1N	1	78.00	0.800	1.420	1.000	1.420	228.05	249.	44	56686.
	1S	1	78.00	0.800	1.420	1.000	1.420	228.05	249.	44	56686.
	2E	1	77.00	0.800	1.420	1.000	1.420	228.05	255.	43	58168.
	2W	1	77.00	0.800	1.420	1.000	1.420	228.05	255.	43	58168.
	3	1	76.00	0.800	1.500	1.000	1.500	254.47	292.	41	74345.
	3N	1	76.00	0.800	1.500	1.000	1.500	254.47	292.	41	74345.
	3S	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
63W	1E	1	79.00	0.800	1.420	1.000	1.420	228.05	249.	44	56686.
	1W	1	77.00	0.800	1.500	1.000	1.500	254.47	285.	41	72426.
	2E	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	2W	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	3E	1	74.00	0.800	1.330	1.000	1.330	200.06	242.	45	48468.
	3W	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
66W	1	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	1N	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	1S	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	2E	1	72.00	0.800	1.580	1.000	1.580	282.34	361.	36	101971.
	2W	1	72.00	0.800	1.750	1.000	1.750	346.36	443.	33	153462.
	3	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3N	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3S	1	71.00	0.800	1.330	1.000	1.330	200.06	263.	43	52651.

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NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
67W	1E	1	73.00	0.800	1.500	1.000	1.500	282.34	351.	37	99196.
	1W	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	2E	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	2W	1	72.00	0.800	1.420	1.000	1.420	228.05	292.	41	66528.
	3	1	71.00	0.800	1.500	1.000	1.500	282.34	371.	36	104864.
	3N	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3S	1	71.00	0.800	1.500	1.000	1.500	282.34	371.	36	104864.
70W	1	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	1N	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	1S	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	2E	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	2N	1	72.00	0.800	1.500	1.000	1.500	282.34	361.	36	101971.
	2W	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3N	1	71.00	0.800	1.500	1.000	1.500	282.34	371.	36	104864.
	3S	1	71.00	0.800	1.330	1.000	1.330	200.06	263.	43	52651.
71W	1E	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	1W	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	2E	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	2W	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	3	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3N	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
	3S	1	71.00	0.800	1.500	1.000	1.500	254.47	335.	38	85185.
72W	1E	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	1W	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	2E	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	2W	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	3	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3N	1	72.00	0.800	1.420	1.000	1.420	228.05	292.	41	66528.
	3S	1	72.00	0.800	1.500	1.000	1.500	282.34	361.	36	101971.
73W	1E	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	1W	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	2E	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	2W	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	3	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3N	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3S	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
74W	1E	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	1W	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	2E	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	2W	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
	3	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3N	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3S	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
NAVAL SUBMARINE BASE, TRIDENT SUPPORT SITE
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
75W	1E	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	1W	1	74.00	0.800	1.420	1.000	1.420	228.05	276.	42	62980.
	2E	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	2W	1	73.00	0.800	1.420	1.000	1.420	228.05	284.	41	64717.
	3	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3N	1	72.00	0.800	1.500	1.000	1.500	254.47	326.	38	82835.
	3S	1	72.00	0.800	1.420	1.000	1.420	228.05	292.	41	66528.
76W	1E	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
	1W	1	75.00	0.800	1.420	1.000	1.420	228.05	269.	42	61312.
	2E	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	2W	1	74.00	0.800	1.500	1.000	1.500	254.47	308.	39	78418.
	3	1	73.00	0.800	1.580	1.000	1.580	282.34	351.	37	99196.
	3N	1	73.00	0.800	1.580	1.000	1.580	282.34	351.	37	99196.
	3S	1	73.00	0.800	1.500	1.000	1.500	254.47	317.	39	80581.
77W	1E	1	76.00	0.800	1.500	1.000	1.500	254.47	292.	41	74345.
	1W	1	76.00	0.800	1.420	1.000	1.420	228.05	262.	43	59709.
	2E	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	2W	1	75.00	0.800	1.500	1.000	1.500	254.47	300.	40	76341.
	3	1	74.00	0.800	1.580	1.000	1.580	282.34	342.	37	96533.
	3N	1	74.00	0.800	1.420	0.005	0.100	1.14	1.	590	2.
	3S	1	74.00	0.800	1.500	0.005	0.106	1.27	2.	558	2.
EAST PIER											
42E	1N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	1S	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	105193.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3S	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
43E	1	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2W	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3	1	63.00	0.800	1.250	1.000	1.250	176.71	295.	40	52176.
46E	1N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	1S	1	63.00	0.800	1.250	1.000	1.250	176.71	295.	40	52176.
	2E	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3S	1	63.00	0.800	1.250	1.000	1.250	176.71	295.	40	52176.
47E	1	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.

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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA INZ	C PSI	L/D	P-ULT LB
	2W	1	63.00	0.800	1.670	1.000	1.670	315.42	527.	30	166226.
	3	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108173.
50E	1N	1	65.00	0.800	1.420	1.000	1.420	228.05	358.	37	81628.
	1S	1	65.00	0.800	1.420	1.000	1.420	228.05	358.	37	81628.
	2E	1	65.00	0.800	1.420	1.000	1.420	228.05	358.	37	81628.
	2W	1	65.00	0.800	1.420	1.000	1.420	228.05	358.	37	81628.
	3N	1	65.00	0.800	1.330	1.000	1.330	200.06	314.	39	62819.
	3S	1	65.00	0.800	1.500	1.000	1.500	254.47	399.	35	101637.
51E	1	1	65.00	0.800	1.580	1.000	1.580	282.34	443.	33	125116.
	2E	1	65.00	0.800	1.580	1.000	1.580	282.34	443.	33	125116.
	2W	1	65.00	0.800	1.420	1.000	1.420	228.05	358.	37	81628.
	3	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
54E	1N	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	1S	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	2E	1	66.00	0.800	1.250	1.000	1.250	176.71	269.	42	47541.
	2W	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	3N	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	3S	1	66.00	0.800	1.580	1.000	1.580	282.34	430.	33	121354.
55D	1	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	2E	1	66.00	0.800	1.330	1.000	1.330	200.06	305.	40	60930.
	2W	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
	3	1	66.00	0.800	1.420	1.000	1.420	228.05	347.	37	79173.
58E	1	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	1N	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	1S	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	2E	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	2W	1	67.00	0.800	1.330	1.000	1.330	200.06	296.	40	59125.
	3	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	3N	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	3S	1	67.00	0.800	1.500	1.000	1.500	254.47	376.	36	95668.
59E	1E	1	67.00	0.800	1.500	1.000	1.500	254.47	376.	36	95668.
	1W	1	67.00	0.800	1.250	1.000	1.250	176.71	261.	43	46132.
	2E	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	2W	1	67.00	0.800	1.420	1.000	1.420	228.05	337.	38	76828.
	3E	1	67.00	0.800	1.330	1.000	1.330	200.06	296.	40	59125.
	3W	1	67.00	0.800	1.580	1.000	1.580	282.34	417.	34	117758.
62E	0N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	0S	1	63.00	0.800	1.250	1.000	1.250	176.71	295.	40	52176.
	1	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	1N	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	1S	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
	2W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3S	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
63E	1E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	1W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2E	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3E	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108193.
	3W	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108193.
66E	1	1	60.00	0.800	1.330	1.000	1.330	200.06	369.	36	73725.
	1N	1	60.00	0.800	1.420	1.000	1.420	228.05	420.	34	95800.
	1S	1	60.00	0.800	1.420	1.000	1.420	228.05	420.	34	95800.
	2E	1	60.00	0.800	1.420	1.000	1.420	228.05	420.	34	95800.
	2W	1	60.00	0.800	1.500	1.000	1.500	254.47	469.	32	119282.
	3	1	60.00	0.800	1.500	1.000	1.500	254.47	469.	32	119282.
	3N	1	60.00	0.800	1.420	1.000	1.420	228.05	420.	34	95800.
	3S	1	60.00	0.800	1.580	1.000	1.580	282.34	520.	30	146838.
67E	1E	1	60.00	0.800	1.330	1.000	1.330	200.06	369.	36	73725.
	1W	1	60.00	0.800	1.330	1.000	1.330	200.06	369.	36	73725.
	2E	1	60.00	0.800	1.330	1.000	1.330	200.06	369.	36	73725.
	2W	1	60.00	0.800	1.330	1.000	1.330	200.06	369.	36	73725.
	3	1	60.00	0.800	1.580	1.000	1.580	282.34	520.	30	146838.
	3N	1	60.00	0.800	1.500	1.000	1.500	254.47	469.	32	119282.
	3S	1	60.00	0.800	1.580	1.000	1.580	282.34	520.	30	146838.
70E	1	1	62.00	0.800	1.250	1.000	1.250	176.71	305.	40	53873.
	1N	1	62.00	0.800	1.250	1.000	1.250	176.71	305.	40	53873.
	1S	1	62.00	0.800	1.330	1.000	1.330	200.06	345.	37	69046.
	2E	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
	2W	1	62.00	0.800	1.330	1.000	1.330	200.06	345.	37	69046.
	3	1	62.00	0.800	1.330	1.000	1.330	200.06	345.	37	69046.
	3N	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
	3S	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
71E	1E	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
	1W	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
	2E	1	62.00	0.800	1.330	1.000	1.330	200.06	345.	37	69046.
	2W	1	62.00	0.800	1.670	1.000	1.670	315.42	544.	30	171631.
	3	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
	3N	1	62.00	0.800	1.330	1.000	1.330	200.06	345.	37	69046.
	3S	1	62.00	0.800	1.420	1.000	1.420	228.05	393.	35	89719.
72E	1E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	1W	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.

MAGNETIC SILENCING FACILITY PILE LOADING CAPACITIES
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BENT	PILE	ITP	LENGTH FT	EFF-L FACTOR	ORG-DIA FT	EFF-ARA FACTOR	EFF-DIA FT	EFF-ARA IN2	C PSI	L/D	P-ULT LB
	2W	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3N	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3S	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
73E	1E	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108193.
	1W	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2E	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3S	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
74E	1E	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	1W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2E	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	2W	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3N	1	63.00	0.800	1.330	1.000	1.330	200.06	334.	38	66871.
	3S	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108193.
75E	1E	1	63.00	0.800	1.500	1.000	1.500	254.47	425.	34	108193.
	1W	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2E	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	2W	1	63.00	0.800	1.670	1.000	1.670	315.42	527.	30	166226.
	3	1	63.00	0.800	1.580	1.000	1.580	282.34	472.	32	133187.
	3N	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
	3S	1	63.00	0.800	1.420	1.000	1.420	228.05	381.	35	86893.
76E	1E	1	64.00	0.800	1.330	1.000	1.330	200.06	324.	38	64798.
	1W	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	2E	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	2W	1	64.00	0.800	1.330	1.000	1.330	200.06	324.	38	64798.
	3	1	64.00	0.800	1.580	1.000	1.580	282.34	457.	32	129857.
	3N	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	3S	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
77E	1E	1	64.00	0.800	1.330	1.000	1.330	200.06	324.	38	64798.
	1W	1	64.00	0.800	1.500	1.000	1.500	254.47	412.	34	104838.
	2E	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	2W	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	3	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	3N	1	64.00	0.800	1.420	1.000	1.420	228.05	369.	36	84199.
	3S	1	64.00	0.800	1.500	1.000	1.500	254.47	412.	34	104838.

APPENDIX

MARINE PILING REPAIR

The criteria of pile repair is to maintain the pile within design parameters and thereby enhance the service life of a structure. Maintenance methods employed can be as varied and innovative as the damage found and will be dictated by numerous factors such as economics, physical access, aesthetics, and operational and structural considerations. The fundamental criteria, nevertheless, is structural. Any repairs implemented should be based on a thorough column, and/or structural analysis of the pile and facility. All significant pile parameters such as length, effective length, fixity conditions, L/d ratio, location of damage, degree of damage (through cross-section and length) and loading conditions (design and current) should be considered both of the damaged pile and the repaired pile. The maintenance design should insure that the repair carried out solves the "damage" problem without creating new problems in terms of structural considerations.

The above simply emphasizes the necessity to design repairs on an individual basis and the cost of these repairs will be determined by the individual cases in question. This not withstanding, some maintenance methods have received considerable acceptance and usage in the industry. Some of these with approximate cost figures are reviewed below.

PILE MAINTENANCE - REPAIR METHOD*	COST**
1. Pile Replacement Removal and replacement of the damaged pile with a new treated wood pile (95' pile at the Bangor WA MSF facility)	$10,000 +
2. Stubbing Method ("Colby Pile") This process consists of exposing the pile at the mudline below the area of deterioration, and the damaged area is removed. A pin is driven into the exposed sound stump and a lightweight tube housing reinforcement bars is attached to the stump and cap. Concrete is pumped into the tube and allowed to harden, after which the bottom and top tube attachments are removed. The loads are transmitted from the cap to the sound pile stub in the mudline by the new reinforced concrete pile section	$3000-$4000

PILE MAINTENANCE - REPAIR METHOD	* COST
3. Concrete Jacket (Fabri Form - Sea Form) This process is used when some portion of the pile cross-section has been damaged or lost. A fabric "sock" is installed, as a mould, around the length of a damaged pile, reinforcing mesh or rods are placed around the pile inside the sock, and the sock is pumped full of concrete. This process has apparently been used successfully even on piling which are subjected to considerable lateral bending.	$3000-$4000 +
4. Oil Drum Method This method is also used in splicing of stubbed piles or in replacing the major portion of a pile's length. In the first case, the damaged section of a pile is removed and replaced with a treated wood pile section. An oil drum with a hole the size of the pile cut in its bottom is fitted around the joint and filled with concrete. A variation on this method is achieved by simply placing the drum around the solid stump and adding additional drums in sequence as required. Reinforcing can be added, if desirable, and the mould, consisting of oil drums, is then filled with concrete	$1000 +

Further data on these methods can be obtained from J. Agi & Associates or directly from contractors.

* The review of these methods should not necessarily be construed as an endorsement of the method by J. Agi & Associates.

** Approximate cost figures in Pacific Northwest.

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